SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER, 1929.

GENERAL PHYSICS.

2874. Densities of Butyric Acid-Water Mixtures. J. Grindley and C. R. Bury. *Chem. Soc., J. pp.* 679–684, *April,* 1929.

From a consideration of the properties of aqueous solutions of butyric acid, should they contain micelles [see Abstract 393 (1928)], it is concluded that an abrupt change must occur in any curves of physical properties of the aqueous solutions when plotted against concentration. These changes are due to micelle formation, and from freezing-point data the change should occur at an acid concentration of approximately 15 %. In order to test this calculated result, the authors measured the densities of aqueous solutions of butyric acid at 0°, 12°, 18°, 25° and 35°, and also estimated partial specific volumes for these temperatures. An abrupt change occurs in the curves at a concentration of 12–15 %, thereby supporting the contention that micelle formation does occur. With increase in temperature the change tends to become less abrupt, whilst the concentration at which this change is greatest decreases with rise in temperature. R. C. F.

2875. Density, Compressibility and Atomic Weight of Argon. G. P. Baxter and H. W. Starkweather. *Nat. Acad. Sci., Proc.* 15. *pp.* 441–444, *May,* 1929.

Continuation of this work [Abstract 1112 (1928)] showed that the argon used contained 0·02 % of hydrogen. The new results give the value 1·78394 for the normal density of argon, but the limiting density is little affected, and the atomic weight found from both series of experiments is 39·944. The method used was essentially the same as before, except that 3-litre globes of the best fused, transparent quartz replaced the 2-litre Pyrex globes. The resulting value of $(PV)_0/(PV)_1$ is 1·00107, which is considerably higher than the value 1·00090, previously obtained, but is in close accord with that found by Baxter and Ellestad in an apparatus for the isothermal measurement (at 0°) of pressure and volume at different pressures. T. H. P.

2876. Density and Cold Deformation. M. Masima and G. Sachs. *Zeits. f. Physik,* 54. 9–10. *pp.* 666–673, 1929.

Gives the results of measurements made on the stretching of brass monocrystals, in which the density was determined for each load; also determinations of the densities of the stretched crystals after annealing at different temperatures. The curves showing the relation between

the density of the cold specimens, and the ratio between sectional area and sectional area before stretching, f/f_0, and those between the load and f/f_0 are given for two crystals, and those between density and annealing temperature for three crystals. The alterations of density in stretching are mainly confined to the region between the end of symmetrical slip and the complete start of the second slipping. Annealing up to 200° C. increases the density, which then diminishes up to 400° C., after which there is rather a sharp rise; the curve then does not alter greatly in height, but falls quickly after 700° C.; this fall, however, is due to vaporisation of the zinc. This behaviour leads to a theory, based on the formation of gaps in the material when the crystals are deformed so that the minute component parts become curved. These gaps disappear when recrystallisation takes place, *i.e.*, when the annealing temperature exceeds 400° C.
H. N. A.

2877. Gravitometer for Recording Rapid Changes of Specific Gravity in Gases. A. Blackie and B. H. Williams. *Journ. Sci. Instruments*, 6. *pp.* 157–160, *May*, 1929.

Details are given of the modification of a Ranarex recorder for use as a gravitometer for the measurement of small differences of specific gravities of gases lighter than air. F. J. W.

2878. Chronograph Registering 0·0001 Second and Its Application to Measure Irregularities of the Astronomical Pendulum. P. Lejay. *Comptes Rendus*, 188. *pp.* 1089–1091, *April* 22, 1929.

Particulars are given of a photographic recording method in which a tuning fork oscillating in front of a slit allows a spot of light to fall intermittently on the photographic film which is rotated on a cylinder. The motion of the cylinder and tuning fork are synchronised, and the effect of the phenomenon to be studied is superposed on this. The light is interrupted by the tuning 100 times per second, and the trace can be estimated to 0·01 of an interruption to give an accuracy of 0·0001 second. Tests have been made on pendulums and give this accuracy. [See Abstract 2882 (1928).] R. S. R.

2879. Relative Gravity Measurements According to the Reference Method with Distant Wireless Control of the Coincidence Apparatus. E. Berger. Preliminary Results. K. Mader. *Gerlands Beitr. z. Geophys.* 21. 4. *pp.* 355–365, 1929.

With the apparatus described a coincidence method is used, with a recording chronograph controlled from a distance by wireless signals to make measurements of the relative values of *g*, the acceleration due to gravity, at an arbitrary number of stations. This coincidence apparatus is driven synchronously by the seconds pendulum of a single astronomical clock common to all the stations. The preliminary results with such a method are given for the difference in *g* at Laxenburg and Vienna.
R. S. R.

2880. Apparatus for Studying Newton's Second Law. P. L. Tea. *J.O.S.A. and R.S.I.* 18. *pp.* 360–364, *April*, 1929.

Attachments to a free-fall apparatus, described in a previous paper [see Abstract 2 (1929)], were developed for the use of students, to study Newton's Second Law experimentally for (1) pure translation, (2) pure rotation, and (3) combined translation and rotation. AUTHOR.

2881. New Method for the Measurement of Small Pressures with a Distant Indicator. A. Simon and F. Fehér. *Zeits. f. Elektrochem.* 35. *pp.* 162–165, *April*, 1929.

This method was devised for dealing with the decomposition tension curves of explosive substances and in principle depends on the production of electromagnetic waves in a radio tube installed as sender by means of an electrical oscillation system. These waves are detected by a suitably tuned system which acts as receiver and in which the pressure apparatus (tensimeter) is installed as a variable condenser. Pressure changes produce movements in a mercury column, which is contained in a tube lined with tinfoil, and capacity variations are given by suitably attached indicators which are calibrated for pressure changes in the tensimeter. Full details are given in the paper. H. H. Ho.

2882. Sensitive Micromanometer. J. L. Hodgson. *Journ. Sci. Instruments*, 6. *pp.* 153–156, *May*, 1929.

The paper describes a new type of micromanometer which is highly sensitive, compact and portable. It was designed for use in mines. The instrument consists of a cylindrical displacer partly immersed in oil which communicates with an inclined glass tube. The displacer is moved by a micrometer screw so as to keep the oil meniscus in a steady position. The instrument can detect pressure changes of the order of 10^{-5} in. of water. A. A. D.

2883. Preparing Clean Mercury. D. Roller. *J.O.S.A. and R.S.I.* 18. *pp.* 357–359, *April*, 1929.

Specifies the various stages gone through in cleaning mercury for photoelectric purposes. Describes a centrifugal mixer consisting of a vertical shaft of a 30-cm. length of 7 mm. glass tubing, to the lower end of which is sealed crosswise a 10-cm. length of similar tubing, bent upwards like an anchor and drawn out to two points 2 mm. in diameter. This tube has a thin opening in its lower centre, opposite the point where it is sealed to the shaft. The mixer is supported vertically in a battery jar containing the mercury and the washing liquid, and should be operated at high speed. E. E. F. d'A.

2884. Damping for Gyro-Compasses. O. Martienssen. *Phys. Zeits.* 30. *pp.* 231–232, *April* 15, 1929.

A reply by the author to a criticism by K. Glitscher [see Abstract 5 (1929)] of his original paper on this subject [see Abstract 2031 (1928)]. It is followed by a further reply from **Glitscher** and a third communication from the original author. J. W. T. W.

2885. Method of Measuring the Periodic Error of a Mechanism. G. A. Tomlinson. *Journ. Sci. Instruments*, 6. *pp.* 152–153, *May*, 1929.

The object is to determine the periodic error in the motion transmitted by a kinematic pair, such as the relative motion of a tool-holder and the spindle of a screw-cutting lathe. The apparatus consists of two electromagnetic markers which are connected in series so as to produce a series of simultaneous kicks on smoked plate records attached to the two components of the pair. A. A. D.

2886. Pressel and Riefler's Curve-Measurer. K. Pressel. *Zeits. f. Instrumentenk.* 49. *pp.* 248–252, *May*, 1929.

Description and discussion of the above apparatus, with data and drawings. A. D.

2887. Apparatus for Demonstrating the Maxwell Velocity Distribution Law. F. A. Schulze. *Phys. Zeits.* 30. *pp.* 325–327, *May* 15, 1929.

For demonstration of the curve of the distribution function of the Maxwell velocity distribution law, which concerns the magnitude but not the direction of the velocity, the procedure is adopted for a so-called two-dimensional gas wherein the molecules are coplanar. From simple considerations it is found that the distribution function ψ becomes $\psi(c) = 2\beta^2 ce^{-\beta^2c^2}$, the only essential difference from the three-dimensional gas being that $e^{-\beta^2c^2}$ is multiplied by c instead of by c^2, the function ψ having the same typical curve as the function ϕ of the three-dimensional gas. In consequence, it is possible to modify Galton's apparatus for the latter case, and a full detailed description, with photograph and diagram, is included in the paper of an installation suitable for the experimental derivation of the requisite curves. H. H. Ho.

2888. Influence of Capillary Dimensions upon Stream Anomalies of Colloids in the Capillary Viscosimeter. W. Haller and V. Trakas. *Kolloid. Zeits.* 47. *pp.* 304–310, *April*, 1929.

The relation Δ/r^3k (where k is the rate of flow and r the radius of the capillary) was pointed out by Hatschek in 1913. At the transition from the laminar zone to structural viscosity [see Abstract 665 (1929)], k should assume a critical value, dependent only upon the nature of the colloid and not upon the dimensions of the capillary. This is tested with aqueous solutions of tannin at various concentrations in the viscosimeter of Ostwald-Auerbach. The viscosity-rate of flow curves do not show any marked inflection, but the appearance of structural viscosity becomes more distinct when the log of the rate is plotted against the log of the pressure. There is a critical value for the structural viscosity, as there is a critical Reynolds number for turbulence. But it is doubtful whether the laminar zone really exists for liquids of the structural viscosity type. The equation of A. de Waele–Wo. Ostwald is modified in a way to make the two constants strictly dependent upon the material, and not upon the dimensions of the apparatus. H. B.

2889. Capillarity. Formulation of Capillary Structures. K. Schultze. *Kolloid Zeits.* 47. *pp.* 310–313, *April*, 1929.

Developments of the symbols [see Abstract 1124 (1928)] proposed for the presentation of capillary phenomena. The formulation of an open capillary can only be referred to one cross-section, when the cross-section is circular. But large radii are grouped about a small radius, a meniscus is generally the sum of many meniscus branches of equal length, and the opening out or narrowing of a capillary branch may favour ascension and evaporation of the liquid or enlargement of the meniscus until an air bubble can burst the surface. H. B.

2890. Capillarity. Diffusion and Concentration Displacements of Salt Solutions in Capillaries. K. Schultze. *Kolloid Zeits.* 48. *pp.* 15–25, *May*, 1929.

As long as the concentration of the salt is insufficient for direct crystallisation, the liquid in the meniscus travels from the centre outward, and new salt is only deposited on the upper crust. Later the crystallisation is not limited to the constricted film, and in the case of KCl a long chain of minute crystals is finally left. The longer this chain, the more the cross-section of the capillary will be found to approach the circular form. The chains may be spiral. Particulars and dimensions are given for various cross-sections, elliptical, concave, convex, plane, club-shaped, etc., and a few other salts. H. B.

2891. Interfacial Tension Between Mineral Oils and Aqueous Solutions. H. Weiss and E. Vellinger. *Comptes Rendus,* 188. *pp.* 901–903, *March* 25, *pp.* 1099–1101, *April* 22, 1929.

(1) The interfacial tension between an aqueous solution and a mineral oil falls progressively during a period of perhaps two hours, the effect being specially marked in the case of the most alkaline solutions ($p_H = 13 \cdot 5$). Two types of curve are found for the relation between interfacial tension and the p_H of the aqueous layer, since crude mineral oils give a single strong maximum in approximately neutral solutions, falling to zero on the alkaline side at $p_H = 11$, whilst refined oils show only small variations with shallow maxima at $p_H = 6 + 11$. (2) The curves showing the relation between the p_H of an aqueous solution and its interfacial tension with a mineral oil can be used to follow the progress of refining and the deterioration of the oil during its use as a lubricant.

T. M. L.

2892. Surface Tension of Binary Fluid Mixtures Consisting of an Associated and a Non-Associated Component. K. M. Stachorsky. *Zeits. f. Elektrochem.* 35. *pp.* 185–186, *April,* 1929.

Describes a method which makes it possible to deduce the degree of molecular association of a purely associated liquid from the surface tension of its concentrated solution in a non-associated liquid. The method of calculation indicated applies to liquid pairs which have no chemical action on each other when they are mixed, and which form no complexes.

H. N. A.

2893. Time Change of the Surface Tension of Solutions of Monovalent Chlorides. E. O. Seitz. *Ann. d. Physik,* 1. 8. *pp.* 1099–1108, *May* 7, 1929.

It is pointed out that where in a liquid or salt solution, in addition to the presence of non-complex simple molecules, there are also molecules and ions present which, through polymerisation or by the addition of molecules of solvent, become complex, there is a time change in the surface tension. In a free surface the concentration of the complex molecules in the surface is the same as that in the interior of the liquid or solution. As the complex molecules possess greater molecular energy than the simple molecules, they disperse towards the interior, and the surface tension therefore is lowered. It is pointed out that the investigated solutions can be divided into two definite classes. The non-volatile salts KCl, NaCl and LiCl, with increase of concentration, increase linearly in the static values of the surface tension at constant temperature; with the volatile solutes, for example, with HCl there is a linear diminution in the static values with increase of concentration. J. K.

2894. Drop-Weight Method for the Measurement of Surface Tension. A. Ferguson. *Journ. Sci. Instruments,* 6. *pp.* 163–167; *Corres.,* 167–168, *May,* 1929.

2895. Surface Tension of Sodium. F. E. Poindexter and Marie Kernaghan. *Phys. Rev.* 33. *pp.* 837–843, *May,* 1929.

The surface tension of molten sodium has been determined by a modified flat-drop method in a high vacuum. In doing so Worthington's correction formula was used:

$$\sigma = \frac{(K - k)^2 \rho}{2} \cdot \frac{1 \cdot 641L}{1 \cdot 641L + (K - k)}.$$

From the best mean-straight line through the experimental points the surface tension at 100° C. and at 250° C. was found to be 206·4 and 199·5 dynes per cm. respectively. Hence the temperature gradient is $-4 \cdot 6 \times 10^{-2}$ dyne per cm. per degree. Consequently, the average value of k, in the Eötvös relation, was found to be 0·067, and it is concluded that the molecules in liquid sodium are polyatomic. The accuracy of the results is based on the high vacuum maintained throughout the period of experimentation. That both the apparatus and the liquid metal were thoroughly outgassed was proved by the fact that the McLeod gauge gave no reading (*i.e.*, a gas pressure $< 17 \times 10^{-6}$ mm. Hg), even while sodium was being distilled over into the cup. Reproduction of concordant results argues against the formation of films on the sodium, adsorbed gases or reaction of the sodium with the glass. AUTHORS.

2896. Definition Approached by the Relative Kinetic Energy of a Liquid which Fills a Rotating Vessel. B. Meisel. *Comptes Rendus*, 188. *pp.* 984–986, *April* 8, 1929.

The liquid is assumed to be incompressible and to fill completely a cylindrical vessel whose generators are parallel to the fixed axes about which the vessel rotates. The relative kinetic energy T is given by $\rho w^2 s^4 / 8\pi^2 J_p$, where ρ is the density of the liquid, s the transverse section of the vessel, and J_p the central polar moment of inertia. T is independent of the position of the vector w of angular rotation, since the relative motion is invariant for all parallel axes of rotation. [See Abstract 2897 (1928).]

H. H. Ho.

2897. Application of Statistical Mechanics to the Theory of Turbulent Fluid Motion. J. M. Burgers. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 414–425, 1929.

The opinion has been expressed by various authors that the problem of turbulent motion has to be attacked by the methods of statistical mechanics. The present paper is a tentative one, in which certain possibilities are examined. It is restricted to the two-dimensional case, as then the stream function may be made the basis of the calculation—in three dimensions it is difficult to find " objects " to " count." Another difficulty which makes the problem very different from those of the kinetic theory, is that the motion is dissipative; this is overcome by considering only the fluctuations from the mean motion. The values of the stream function at the lattice-points of a Cartesian net are taken as " objects," and an equation for the most probable distribution is obtained. W. G. B.

2898. Criterion for Turbulence in Curved Pipes. G. I. Taylor, *Roy. Soc., Proc.* 124. *pp.* 243–249, *June* 4, 1929.

Experiments are described in which coloured fluid is introduced through a small hole in the side of a glass helix through which water is running. The conclusion reached by C. M. White [see Abstract 2348 (1929)], as a result of resistance measurements, that a higher speed of flow is necessary to maintain turbulence in a curved pipe than in a straight one, is verified directly. In a pipe bent into a helix the diameter of which was eighteen times that of the cross-section, steady stream-line motion persisted up to a Reynolds number, 5830, *i.e.*, 2·8 times Reynolds' criterion for a straight pipe. This occurred in spite of the fact that the flow was highly turbulent on entering the helix. AUTHOR.

2899. Hydrodynamic Forces Acting on a Cylinder in Motion, and the Idea of a "Hydrodynamic Centre." W. G. Bickley. *Roy. Soc., Proc.* 124. *pp.* 296–303, *June* 4, 1929.

Formulæ are found for the forces acting on a cylinder in the most general motion in a fluid, and it is shown that by referring to an origin permanently fixed relative to the body, these formulæ are considerably simplified; in particular the velocity of this point must be used in the well-known formula to give the force due to "circulation." It is the limit to which the centre of the stream-lines due to circulation *only* tends as these tend to infinity. W. G. B.

2900. Resistance of Bent Pipes. H. Lorenz. *Phys. Zeits.* 30. *pp.* 228–230, *April* 15, 1929.

Discusses mathematically the problem of the loss of pressure at a bend in a pipe through which a fluid is flowing. The formula deduced is $\Delta p = (\phi/\pi)(u_0\gamma/2g)\zeta$, where ϕ is the angle embraced by the band (in radians), u_0 is the velocity of flow and γ the density of the fluid, while $\zeta \equiv 2a/r_0 + \pi\lambda r_0/a$, where a and r_0 are respectively the radii of the pipe and of the circle of curvature and λ is the coefficient of friction of the pipe. The results given by this formula agree satisfactorily with those obtained experimentally. J. W. T. W.

2901. Suspension of Sand in Water. H. E. Hurst. *Roy. Soc., Proc.* 124. *pp.* 196–201, *May* 2, 1929.

The experiments now described were undertaken to find the laws governing the suspension in water of fairly large particles, such as river sand. Since suspension must be due to turbulent motion, an apparatus has been designed to give such motion as far as possible and uniformly distributed without any steady flow. It was found that under such conditions the particles behave like the molecules in a gas. It is hoped that this analogy will be fruitful when applied to the practical problems arising out of the suspension of solid particles in the water of streams, and also in the kinetic theory of gases, since a suspension may be looked upon as a model of a gas. H. H. Ho.

2902. General Theory of Elastic Stability. C. B. Biezeno and H. Hencky. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 444–456, 1929.

In a previous investigation (*ibid.*, 31. p. 569, 1928) the authors derived the differential equations which have to be fulfilled by the so-called "additional stress components," S_x, S_y, S_z, t_x, t_y, t_z, that will bring an elastic body from a given state of stress (1) into another state, (2) differing from the former one only by an infinitely small amount. The deduction of the equations was given in such a way that the relations which had to be assumed between these additional stresses and the strains produced by them were introduced only at the end of the calculations. There still remained the problems: (*a*) to enunciate a stress relation which takes into account that the specific deformations in general will be finite (though they will be small compared to unity); and (*b*) to give this relation in a form applicable to the calculation of the "additional stress components" s_x . . . t_x . . . and these are solved in the present paper, which is entirely mathematical. H. H. Ho.

2903. Stress Systems in an Infinite Strip. R. C. J. Howland. *Roy. Soc., Proc.* 124. *pp.* 89–119, *May* 2, 1929.

The stress distribution in an infinite elastic strip due to longitudinal or transverse force acting at any point, in the plane of the strip, is obtained. The results are compared with the elementary theory. The characteristic effects of an isolated force are not appreciable at a distance equal to the breadth of the strip, if the force is longitudinal, or at 1½ times this distance, if the force is transversal. W. G. B.

2904. New Type of Spring. D. Wolkowitsch. *Comptes Rendus*, 188. *pp.* 1228–1230, *May* 6, 1929.

Described a helical spring made by winding a bar, the section of which has a single axis of symmetry (a **V**-section, for example), round a cylinder of suitable radius. The dimensions and arrangements are such that there is no torsion when load is applied, but only simple shear. Such a spring will, for the same amount of absorbed energy, be even lighter than a stretched wire or rod, and much lighter than an ordinary helical spring in which torsion takes place, or than a spiral spring or bent rod. H. N. A.

2905. Tensile Strength of Rolled Molybdenum. T. Fujiwara. *Kyoto Coll. Sci., Mem.* 12. *pp.* 165–178, *May*, 1929. *In English.*

All the specimens were cut in different directions from a rolled foil of molybdenum, 35 by 8 cm., 0·009 cm. thick. The strips, 0·55 cm. wide, 7 to 13 cm. long, were tested when stressed on a testing machine at angles of 0°, 22·5°, 45°, 67·5° and 90° to the direction of rolling. The fractures were examined by photography and X-rays as explained in previous papers. The tensile strength was greatest, about 114 kg./mm.^{2}, in the direction of rolling, but the values fluctuated between 95 and 120 kg. The average value at angles of 45° and 90° to the direction of rolling was about 20 % smaller. Many of the strips were broken in the test, and it is inferred from the direction of the line of fracture that the break occurred at the planes (211) and (110) of the cubic crystal of molybdenum. H. B.

2906. Buckling of Straight Rods Under Eccentric Compressive Forces. R. Chambaud. *Comptes Rendus*, 188. *pp.* 1226–1228, *May* 6, 1929.

Calculations from the exact formulæ involving Elliptic Functions show, of course, no sudden discontinuity, as in the Euler theory, for a central load, nor the infinity for an eccentric one: but in the latter case the deflection reaches a maximum for a load less than the Euler critical one, and then decreases. Taking the criterion of rupture to be stress exceeding the elastic limit, tables (not given) have been constructed to show how the breaking load depends upon the dimensions and the eccentricity. W. G. B.

2907. Theory of the Plasticity of Metals. H. Shôji. *Tohoku Univ., Sci. Reports*, 18. *pp.* 1–9, *May*, 1929. *In English. Report No.* 213 *from the Research Inst. for Iron, Steel and other Metals.*

This paper continues previous work [see Abstract 403 (1929)] in which the results of experiments upon the plasticity of metals were found to be expressed by a constant, $\mathrm{P} = \frac{1}{w_0}\frac{dv}{dw}$, as a measure of plasticity. In the present publication a theoretical investigation of the plasticity of metals is submitted in which the principle of superposition is assumed, and the results are found to require two constants, *viz.*, $p = \frac{v}{l} \Big/ \frac{(w - w_0)}{s}$ and $q = w_0/s$, where s is the cross-section, w the applied weight, w_0 the weight corresponding to the elastic limit, l the length and v the velocity of elongation. H. H. Ho.

2908. Conformal Projection of the Sphere Within a Square. O. S. Adams. *Dept. of Commerce, Special Publ. No.* 153. [13 *pp.*], 1929.

The conformal projection of a sphere within a square with the poles on one of the diagonals and symmetrically placed relative to the centre is discussed. The method employed reduces mathematical computation very much, although the amount of calculation necessary is still considerable. The required functions are evaluated and tabulated. The whole sphere is first mapped conformally on the hemisphere, and the required projection derived by the use of elliptic isometric coordinates. J. S. G. T.

2909. Pfaffien Systems of G. Birkhoff. L. Féraud. *Comptes Rendus,* 188. *pp.* 1029–1031, *April* 15, *and pp.* 1144–1146, *April* 29, 1929. *In English.*

In this paper the author discusses certain systems of dynamical equations termed by Birkhoff, " Pfaffien Systems," which are useful in the variation problem. The theorems of Poisson and de Lie are applicable to them as to the Hamiltonian systems, and as an example the reduction of the Lagrangian to the Pfaffien form is given. The author applies the above system to certain dynamical problems, and as an illustration of the advantages of the method he determines the final order (after the greatest reduction possible has been made) in such classical cases as " Three bodies in a plane," " Three Bodies," " *n* Bodies." Finally, for the particular case of two degrees of freedom, the author reduces a Pfaffien system to the Hamiltonian form in the neighbourhood of an equilibrium point. H. H. Ho.

2910. Single Crystal of Zinc with Approximately any Desired Orientation of Its Principal Axis. S. Ito. *Kyoto Coll. Sci., Mem.* 12. *pp.* 97–106, *March,* 1929. *In English.*

When a single crystal of zinc of known orientation welded at one end to a zinc plate, is just melted and then gradually cooled from the weld to the other end, a single crystal is produced with approximately the same orientation of the principal axis as the " parent " crystal. Photographs are given and the homogeneity of the arrangement was tested by X-ray analysis, using the method. J. E.

2911. Etch Figures of Aluminium and Zinc. B. Fujita. *Kyoto Coll. Sci., Mem.* 12. *pp.* 159–163, *May,* 1929. *In English.*

The facets developed by etching the surface of a block of the single metal crystal were determined by optical goniometry and X-ray analysis. For aluminium the facets are (100) and (110), the intensity of light reflected from the (110) facets being much fainter than that from the (100). For zinc the facets were (0001) and (10$\bar{1}$0). The results for aluminium were independent of the conditions of etching over the range, HCl, HF and NaOH at concentrations varying from 5 to 50 %. W. H. Ge.

2912. Relation Between Lattice Constant and Density of Solid Solutions. S. Sekito. *Tohoku Univ., Sci. Reports,* 18. *pp.* 59–68, *May,* 1929. *In English. Report No.* 216 *from the Research Inst. for Iron, Steel and other Metals.*

This paper contains the results of the determination of the lattice constant of several series of solid solutions containing copper. The density of these alloys, as given by direct measurement, is always greater than those given by those of the constituent metals by the additive law, but coincides satisfactorily with those calculated from the observed lattice constant. Hence, it is to be concluded that in a solid solution a change in density is caused by a change in the lattice constant. AUTHOR.

2913. X-Ray Analysis of the Chromium-Nitrogen System and Study of the Constitution of Ferro-Chromium Alloys Containing Nitrogen. R. Blix. *Zeits. f. phys. Chem.* 3. *Abt. B.* 3. *pp.* 229–239, *May,* 1929.

An X-ray investigation of chromium-nitrogen alloys formed by heating chromium in ammonia at 800°, indicates that two phases are formed. The one, which probably corresponds with Cr_2N, is homogeneous over a fairly wide concentration range. The chromium atoms are arranged in a hexagonal close-packed lattice, with the nitrogen atoms distributed at random among the vacant spaces between the chromium atoms. The lattice parameters increase with increasing nitrogen content. The other phase corresponds with CrN and has the sodium-chloride structure: lattice parameter 4·140 Å., an X-ray analysis of a ferrochromium alloy containing nitrogen (60·3 % Cr, 2·4 % N, 2·00 % Si and 0·21 % C) indicates that the nitrogen is mostly combined with the chromium to form Cr_2N. F. J. W.

2914. X-Ray Study of the Crystalline State of Iron. R. Bach. *Helv. Phys. Acta.* 2. 2. *pp.* 95–114, 1929. *In French.*

By means of a differential method powder photographs have been obtained, showing the variation of the lattice constant between 700° and 1400° and the changes at the transformation points. At a temperature between 750° and 860°, depending on the amount and kind of impurities, a discontinuity has been observed corresponding to the $\alpha \rightarrow \beta$ transformation. The following conclusions are reached: (1) From the room-temperature to fusion point there exist only 2 allotropic forms, body-centred with α, β and δ varieties and face-centred or γ-iron. (2) The varieties β and δ appear to be the same, since the continuation of the dilatation curve of the first coincides with that of the second. (3) In the interval 900–1400 the dilatation curve of γ iron appears to be parallel to the continuation of the β line. (4) The contraction indicated in the passage $\alpha \rightarrow \beta$ appears to be greater than that attributable to the disappearance of spontaneous magnetisation. It is doubted, therefore, whether the α state is distinguished from the β state *uniquely* by magnetic differences. J. E.

2915. Grating Constants of α-Iron. G. Mayer. *Zeits. f. Krist.* 70. 4. *pp.* 383–384, *May,* 1929.

Photographs were taken of iron prepared from iron carbonate mixed with NaCl for comparison measurements. The result was $\alpha_L = 2{,}861_{06} \pm 3$ Å. J. E.

2916. X-Ray Investigation of Iron-Nitrogen Alloys. A. Ôsawa and S. Iwaizumi. *Tohoku Univ., Sci. Reports*, 18. *pp.* 78–89, *May*, 1929. *In English. Report* No. 218 *from the Research Inst. for Iron, Steel and other Metals.*

The atomic arrangement of these compounds is studied with the aid of a Siegbahn-Hadding bulb, four photographs being taken simultaneously with exposures of 8 hours. The specimens, black powders, were prepared by passing ammonia gas over reduced iron heated in a furnace. The lattice constant of the Armco iron, 2·847 Å., increased to 2·869 Å. when the iron contained 0·06 % of nitrogen. As the nitrogen contents increased to 5·9 % the body-centred cube gave way more and more to a face-centred cube. There are two compounds, Fe_4N and Fe_2N. The former crystals are cubic, calculated density 6·47, constant 3·86 Å.; the iron atoms are face-centred with one N in each cube. The Fe_2N are hexagonal, density 5·02; the iron atoms form a closely packed hexagonal lattice with one nitrogen in each parallelopiped; the lattice constants increase with increasing N contents, while the axial ratio decreases, suggesting a solid solution of iron in the compound. The change of lattice is satisfactorily explained, and the diameter 1·26 Å. of the nitrogen atom, deduced from the Fe_4N lattice, agrees with other calculations by Bragg.
H. B.

2917. Lattice Constant of Quenched Carbon Steels. S. Sekito. *Tohoku Univ., Sci. Reports*, 18. *pp.* 69–77, *May*, 1929. *In English. Report No.* 217 *from the Research Inst. for Iron, Steel and other Metals.*

In an earlier communication K. Honda and the present writer [see Abstract 3328 (1928)] reported that the body-centred tetragonal lattice with an axial ratio of about 1·07 appears on the surface layer in quenched carbon steels only, while in the interior the lattice is the ordinary body-centred cubic, and they explained the mechanism of the formation of these lattices. In the present communication it is shown that the axial ratio of the tetragonal lattice diminishes in magnitude from the surface to the interior, finally taking the value 1. The axial ratio of the tetragonal lattice increases with the carbon content, as well as with the quenching temperature. AUTHOR.

2918. Circle-Packing of Niggli. F. Haag. *Zeits. f. Krist.* 70. 4. *pp.* 353–366, *May*, 1929.

Niggli formulated 29 kinds of arrangements of touching circles distinguishing them by the number of radii from the centre of a given circle to the centres of the touching circles and by the arrangement of these radii. In this paper the possible systems are distinguished in accordance with their symmetry relationships. J. E.

2919. Grating Constants of Gypsum. S. v. Friesen. *Zeits. f. Physik*, 54. 9–10. *pp.* 679–685, 1929.

Nagy [see Abstract 693 (1929)] found variations of 0·5 % in the same crystal to 2·5 % in different crystals. The present measurements with a Siegbahn precision spectrometer indicate no such variation. The value of the X-ray refraction index is deduced from the results. J. E.

2920 X-Ray Study of Lublinite. Sophie Mizgier. *Zeits. f. Krist.* 70. 1–2. *pp.* 160–162, *April*, 1929.

From X-ray powder photographs it is deduced that the mineral "lublinite" is identical with calcite. W. H. GE.

2921. Fourier Series Determination of Parameters in Crystal Structures. W. L. Bragg. *Roy. Soc., Proc.* 123. *pp.* 537–559, *April* 8, 1929.

The representation of the scattering matter in a crystal by Fourier Series is here applied to the determination of the parameters in a complex crystal. A series is used which gives the projection of the scattering matter in the unit cell on each of its faces in turn. For instance, when projection is made on the (100) face of the cell, the formula for the density $\rho(y, z)$ of the scattering matter at a point y, z is:

$$\rho(y, z) = (1/bc \sin \alpha) \sum_{-\infty}^{+\infty} \sum_{-\infty}^{+\infty} F(okl) \cos 2\pi(ky/b + lz/c),$$

where $F(okl)$ is the value of the structure factor for the reflection (okl) measured in absolute units. The formula applies to a cell of any shape provided that it has a centre of symmetry. F (000) is taken to be the number of electrons in the unit cell. Evaluation of the series for diopside $CaMg(SiO_3)_2$ gave values of the 14 parameters, agreeing well with those determined elsewhere. It is concluded that the labour of analysing complex crystals may be considerably reduced by using Fourier series in conjunction with an analysis of the usual type made by assigning parameters to the atoms. [See also Bragg and West (*Zeits. f. Krist.* 69, p. 118, 1928), "A Technique for the X-ray Examination of Crystal Structures with Many Parameters."] W. H. Ge.

2922. Symmetry of Homogeneous Plane Point-Groups. L. Weber. *Zeits. f. Krist.* 70. 4. *pp.* 309–327, *May*, 1929.

A theoretical treatment of points systems in a plane, similar to space-group theory in three dimensions. W. H. Ge.

2923. Eighty Two-Dimensional Space Groups. E. Alexander and K. Hermann. *Zeits. f. Krist.* 70. 4. *pp.* 328–345, *May*, 1929.

Theoretical deduction of the 80 space groups of symmetry distribution in two dimensions analagous to the 230 space groups of three-dimensional symmetry distribution. The work has application in the study of liquid crystals. [See Abstract 2658 (1929).] W. H. Ge.

2924. Geometry of Plane Nets. F. Haag. *Zeits. f. Krist.* 70. 4. *pp.* 346–352, *May*, 1929.

A note on the geometry of packing of circles in a plane network. W. H. Ge.

2925. Systematic Arrangement of the Unidimensional Space Groups. E. Alexander. *Zeits. f. Krist.* 70. 4. *pp.* 367–382. *May*, 1929.

Unidimensional space groups are those whose equivalent, "gleichwertige," points all have the same distance from a certain straight line. Besides the unidimensional space groups there exist only the 230 space groups which are of importance in crystallography, the translation lattices, and the eighty two-dimensional space groups with point meshes, treated by K. Herrmann and the author. The present arrangement is based on the general theoretical considerations of Schoenflies and his symbols are employed. The possible number of these space groups is unlimited. The paper contains tables and a number of diagrams which embody the results. H. N. A.

2926. Lattice Constants and Density of KF, CsCl and BaF$_2$. E. Broch, I. Oftedal and A. Pabst. *Zeits. f. phys. Chem.* 3. *Abt. B* 3. *pp.* 209–214, *May,* 1929.

Precision measurements of the lattice constants of pure specimens gave the mean values KF 5·333 Å., CsCl 4·113 Å. and BaF$_2$ 6·184 Å. and densities of 2·5283, 3·9905 and 4·8943 respectively. W. H. Ge.

2927. X-Ray Diagram of Native Cellulose. K. R. Andress. *Zeits. f. phys. Chem.* 2. *Abt. B* 5-6. *pp.* 380–394, *April,* 1929.

It is found that the intensities calculated from Meyer and Mark's structural model of cellulose [see Abstract 1042 (1929)] agree well with those determined experimentally. F. J. W.

2928. Phenomena of Orientation and Pseudo-Crystallisation Resulting from the Effect of Strain upon Colloidal Gels. J. J. Trillat. *Comptes Rendus,* 188. *pp.* 1246–1248, *May* 6, 1929.

Films of nitro-cellulose or of cellulose acetate are susceptible of becoming birefringent when strained, and this phenomena has now been quantitatively studied by means of X-ray diagrams. For this purpose films have been prepared strained in three perpendicular directions, and it was found that: (1) Molecular anisotropy appeared according to the degree of strain. (2) From the measurements the average degree of oscillation of the molecules could be evaluated. (3) For very great strain the diagrams assume a very remarkable appearance, the rings being deformed into ellipses. (4) The passage from the amorphous state to one bordering on crystalline ensues gradually in stages, the final structure being pseudo-crystalline in which the molecules occupy similar positions to those in the crystal lattice, but where they are not perfectly aligned. Such specimens are very strongly birefringent. (5) The phenomena are in excellent agreement with the hypothesis that a molecular statistical arrangement exists analogous to that of a liquid which has been rapidly congealed. (6) The directional mechanical properties are explained by the structures suggested, whilst it is possible to modify chemical properties without a change of constitution. H. H. Ho.

2929. Structure of Some Aromatic Substances. J. Hengstenberg and H. Mark. *Zeits. f. Krist.* 70. *pp.* 283–296, *April,* 1929.

Rotation photographs by the Weisenberg and Schenk methods were obtained giving the space group and the unit cell of diphenyl phenanthrene and fluorene. The agreement in the dimensions of the unit cell and the similarity in intensity distribution of diphenyl and fluorene, together with the fact that diphenyl crystals have a centre of symmetry, leads to the conclusion that in fluorene the two benzene rings lie in parallel planes. A comparison of the unit cells in diphenyl and stibin ($C_6H_5-CH=CH-C_6H_5$) indicates that the "a" period is a measure of the molecular length. This purely qualitative result must be confirmed by intensity measurements. J. E.

2930. Structure of Artificial Ultramarines. F. M. Jaeger. *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 156–166, 1929.

The differences in structure of ultramarines prepared by the substitution of the sodium in Guimet's ultramarine by Th, Ca, Ba, Sr, Zn, Mn and Pb have been determined by X-ray analysis. Differences in colour correspond with differences in crystal structure. No general relations are established. As regards chemical composition, equilibria are reached which depend on the concentration and temperature. [See also Abstract 45 (1929).] J. E.

2931. Structure of Artificial Ultramarines. F. M. Jaeger and F. A. van Melle. *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 167–181, 1929.

The rate of reaching the equilibrium state is studied. The shape of the curves indicates absorption phenomenon. An attempt is made to fix the space group of nosean ($Na_{10}\ Al_6\ Si_6\ O_{32}\ S_2$). The structure is considered as made up of fixed ions $Na_8\ Al_6\ Si_6\ O_{24}$, fixed SO_4 ions and two errant Na or substituted ions. T_d^4 is considered to be the most probable in view of intensity and other considerations. A picture is given of the supposed structure. This structure leaves a large space in the middle of the unit cell (cubical with $a = 3{\cdot}7$ Å.U.) for the accommodation of the errant ions. With ultramarines of greater S content than nosean it is supposed that the extra S forms errant ions either by itself or as NaS, etc. The practical identity of X-ray diagrams of ultramarines of widely different chemical compositions is attributed to isomorphism of structures in which the fixed radicle is $Na_8\ Al_x\ Si_{(12-x)}\ O_{24}$ with $Al + Si = 12$. J. E.

2932. Crystal Structure of Solid Methane. J. C. McLennan and W. G. Plummer. *Phil. Mag.* 7. pp. 761–774, *May*, 1929.

Minute crystals of methane were deposited on a copper capillary tube containing liquid hydrogen or liquid air. The tube was in the axis of the Debye-Scherrer camera which was first evacuated, after which methane was admitted. Typical "powder" photographs of solid methane were obtained, and tables are given containing the deduced experimental spacings, the corresponding theoretical spacings and the indices of the corresponding planes. Consideration of the intensities of the lines leads to either space group T^2 or T_d^2, with four molecules per unit cell. The positions of the hydrogen atoms are given in terms of a parameter u, but $u = 0$ apparently gives the nearest correspondence to the observed intensities, and the agreement becomes fairly close if the Ponte factor for the reflecting power of the carbon atom for high-frequency rays (which varies with the spacing) is used, instead of the usual factor 6. It appears, then, that a cubic form of methane really exists, the molecules being arranged upon a face-centred lattice. The authors conclude that for substances of the type Ca_4 the occurrence of the electrically symmetrical molecule is to be expected just as frequently as that of the pyramidal type. H. N. A.

2933. Electric Conduction in Ionic Crystals (Rock-Salt). Influences of Heat, Water and Plastic Deformation. F. Quittner and A. Smekal. *Zeits. f. phys. Chem.* 3. *Abt. B* 2. *pp.* 162–165, *May*, 1929.

Further evidence in support of the view [see Abstract 392 (1929)] that the crystal ions in the perfect lattice are unable to migrate in an electric field, whilst the ions on the surface of the minute hollows in the crystal are in a looser position and can migrate. Crystals from solutions of rock-salt, purified by electrolysis, show an increased conductivity after being heated for short periods (minutes) up to 400° C. max.; long-continued electrolysis in strong fields lowers the conductivity again, but not below the initial value. Crystals from fused salt show an initial higher conductivity which decreases on heating, but may rise on renewed heating. Evidently the heat has a loosening effect. When the surface layer of the crystals is dissolved off in water, the dried crystal has a much higher conductivity, up to 60 times as high, especially with badly conducting crystals; this increase is lost again by electrolysis. Thus the influence of the water must have penetrated into the interior of the crystal. Small load stress increased the conductivity of sylvin, stronger loads decreased it again, and the temperature effects were less marked under plastic deformation; this is ascribed to recrystallisation without grain formation. The general conclusion, supported by discoloration experiments by radium rays, is that tempering and plastic deformation change the loose structure of the crystals. H. B.

2934. Hydrogen-Ion Wave Function. V. Guillemin, Jr., and C. Zener. *Nat. Acad. Sci., Proc.* 15. *pp.* 314–318, *April* 15, 1929.

The problem is attacked by the variation method. The energy for different internuclear distances, R, is calculated from a value of the eigenfunction ψ, which satisfies the conditions that at zero internuclear separation ψ becomes the solution for He, while for infinite separation it reduces to the hydrogen function. The energy values are quite close to those calculated by Burrau. It is not to be expected that the assumed value of the eigenfunction is as accurate as the energy values suggest, since the variation method gives better eigenwerte than eigenfunctions. A graph shows the relations between the energy and the internuclear distance with a minimum value of E (— 1·205). This is compared with the value obtained by the conventional perturbation method, which is of the same order.

H. N. A.

2935. Reflection of Hydrogen Atoms from Crystals. T. H. Johnson. *Frank. Inst., J.* 207. *pp.* 629–643, *May,* 1929.

The apparatus and general method of the first investigation described were the same as described previously [see Abstract 388 (1929)]. Intensity measurements of the beam of hydrogen atoms specularly reflected from heated crystals of rock-salt were made on glass plates coated with molybdenum oxide, the oxide coating becoming darkened by reduction where the hydrogen atoms struck it. The results obtained show that as the angle of incidence (θ) decreases from 90° (grazing incidence) the intensity of the specularly reflected beam decreases slowly at first. From about 60° to 30° the decrease is more rapid. It was also found that the ratio of the intensity for a small angle of incidence to that for a large angle becomes greater as the temperature of the crystal is reduced, and that for any particular angle the intensity of the specularly reflected beam is greater at low temperatures than at higher ones. Ellett and Olson have recently found that a beam of cadmium atoms, specularly reflected from a crystal of rock-salt, is of homogeneous velocity, selected according to the angle in a manner analagous with the Bragg interference of X-rays. This result is quite inconsistent with wave mechanics expectations. In order to test whether any such effect occurred in the case of hydrogen atoms a beam specularly reflected at an angle of about 20° from grazing incidence was reflected at the same angle from a second crystal. The results obtained were entirely negative, exposures of 10 hours showing no trace of reflection from the second crystal, although reflection from the first crystal could be observed with an exposure of half an hour. A. W.

2936. New Calculation of the Energy of Helium in the Ground State and of the Deepest Term of Ortho-Helium. E. A. Hylleraas. *Zeits. f. Physik,* 54. 5–6. *pp.* 347–366, 1929.

A new method is used by means of which the agreement with the values found spectroscopically can be followed into the region of the fine structure. The use of angles in the calculation is avoided, and only metrical distances which have a direct physical meaning are used as independent variables. The calculations are not carried so far in the case of ortho-helium as in that of helium, but even here a value is obtained by simple means which is so good that it is possible to conclude with certainty that there is absolute agreement between theory and experiment. The method is notable for extremely rapid convergence. In the case of the ground state of helium the calculated value differs from the observed value only by an amount of the order of magnitude of the correction for the motion of the nucleus, plus the relativistic and magnetic corrections.

H. N. A.

2937. Energy of Helium Atom in the Ground State. E. A. Hylleraas. *Phys. Zeits.* 30. *pp.* 249–250, *May* 1, 1929.

Mentions several previous attempts to solve the problem by means of classical and of quantum mechanics, and gives a new solution. The "eigenwert" problem of the helium atom is six dimensional, but for the S-terms can be reduced to a three dimensional one with say r_1, r_2 and θ as independent variables. It is better, however, to use r_{12}, the distance between the two electrons, as the third independent variable, as this simplifies the calculations amazingly. The value obtained for the energy λ in the first approximation is $\lambda = -1{\cdot}4238$, in the second approximation, when the dependence of the "eigenfunction" on r_{12} is considered for the first time, $\lambda = -1{\cdot}4456$, the third approximation gives $-1{\cdot}45123$, and after this the alteration becomes very small, so that at the sixth approximation $\lambda = -1{\cdot}45162$. From Lyman's spectroscopic result $\lambda = -1{\cdot}45175$. The author's previous calculations gave only $\lambda = 1{\cdot}4496$; the agreement of the present result with observation lies practically within the region of the fine structure.

H. N. A.

2938. Properties of the Terms of the Helium Molecule. G. H. Dieke. *Nature,* 123. *pp.* 716–717, *May* 11, 1929.

In most diatomic molecules the influence of the internuclear axis on the valence electron is strong compared with the influence of the nuclear rotation (case I). In case II the influence of the rotation is predominant. Weizel has shown, in a qualitative way, that in the helium band spectrum all the different stages of progression between cases I and II can be recognised. The terms which are produced by the different orientations of orbits, with the vector l representing the moment of momentum of the electron equal to two are of special interest; the properties of the bands which originate from a combination of this complex with the $2p$ level can be understood if one follows the transition from case I to case II. Gives an account of the way in which the existence of P-, Q-, and R-branches varies with the value of j, the total moment of momentum of the molecule. Many of the results obtained are in excellent agreement with experiment, while others are found to be in agreement so far as the data permit of a test.

H. N. A.

2939. Chemical Composition and Dispersity of Crystalline Particles. Wo. Ostwald and A. v. Buzágh. *Kolloid Zeits.* 47. *pp.* 314–323, *April,* 1929.

Rinne pointed out in 1921 that the stereochemical structure as revealed by Röntgen-ray analysis does not agree with the stoichiometric composition. Thus fluorspar seems to be $Ca_{14}F_8$ by X-ray analysis, and CaF_2 by chemical analysis. The reason is that in crystals of infinite dimensions every Ca counts 1, when in the body centre, but only $\frac{1}{2}$ in the face centre, and only $\frac{1}{8}$ at a corner. The discrepancy tends to vanish as the crystals become very small and in the surface zones. The authors calculate the numbers n of unit cells for which the difference would vanish and the apparent (X-ray) ratio Ca : F = 1·75 would become approximately Ca : F = 0·5, and the edge s of the hypothetical unit cube. These values are, for the rock-salt type $n = 1 - 2 \times 10^3$, $s = 8 - 14$ cm.$^{-7}$, fluorspar type $4·5 \times 10^3$ and 300 cm.$^{-7}$ cæsium chloride and cuprite types about 1×10^5 and 400 cm.$^{-7}$. The s values are typical colloidal dimensions. It follows that the compositions of the particles of sols and of highly disperse precipitates should vary with the size of the particles, and that the particles will differ in composition with the degree of dispersity, age and surface development. Smekal's real crystals and lattice blocks would be of correct chemical composition. H. B.

2940. Physical Foundations of Chemical Theory. T. M. Lowry. *Nature*, 123. *pp.* 571–575, *April* 13, 1929.

Gives an account of the relations between the quantum numbers n, l, j and m in the modern theory of atomic structure, and shows by a number of examples that the valencies of different elements can be explained by their atomic structure, as deduced from spectroscopic evidence. Calls particular attention to a work "Die Valenzzahl und ihre Beziehungen zum Bau der Atome" by H. Lessheim and R. Samuel, and comes to the conclusion that facts such as those adduced provide ideal evidence in support of the electronic theory of valency, which can now be regarded as being experimentally proved to be correct. H. N. A.

2941. Mesophases or Intermediate States of Aggregation. Part I. H. Zocher and V. Birstein. *Zeits. f. phys. Chem.* 141. *Abt. A*, 5–6. *pp.* 413–423, *May*, 1929.

This paper deals with the existence of mesophases. First the various conceptions of "state of aggregation," "solid," "liquid" and "mesophase" are defined, and the necessary elasticities for the mesophases evaluated. Molecular groups with periodicities not determined by the phase structure behave in the mesophases as in amorphous systems. The behaviour of mesophases with respect to Röntgen radiation is considered.
H. H. Ho.

2942. Electronic Explanation of Organic Compounds, Especially Benzene. M. Ulmann. *Zeits. f. Elektrochem.* 35. *pp.* 268–274, *May*, 1929.

In this theoretical paper, such subjects as the foundations of the electronic structure of the atom and molecule, organic molecules as polar systems, and the structure of the benzene molecule, are considered.
T. H. P.

2943. Size of the Molecules of Fatty Acids. F. J. Hill. *Phil. Mag.* 7. *pp.* 940–946, *June*, 1929. *Supplement.*

The assumption that the amount of oil necessary to give the critical point at which the surface tension changes corresponds to a layer of thickness of one molecule, which has been confirmed by X-ray analysis, has been applied by Langmuir in his work on the orientation of molecules of substances floating on water using a balance method. The present work describes experiments to determine similar quantities for oleic, palmitic

and stearic acids, but employs a method which combines du Nouy's tensiometer and Ferguson's sphere method; full details are included in the paper. Although the results agree fairly well with Langmuir's, there are certain discrepancies between the values for palmitic and stearic acids.
H. H. Ho.

2944. Zigzag Structure of a Hydrocarbon Chain. A. Müller. *Roy. Soc., Proc.* 124. *pp.* 317–321, *June* 4, 1929.

X-ray investigation of a single crystal of $C_{29}H_{60}$ has shown [see Abstract 46 (1929)] that the CH_2 groups of the chain molecule lie equally spaced on two parallel rows, the lines between successive centres thus forming a zigzag. This paper attempts to show how a number of observations on their physical properties are connected with the zigzag structure of the chain molecule. It is demonstrated that centro-symmetrical linkage is to be expected if the end groups are electric—or magnetic dipoles; features of the crystal habit of long chain compounds are discussed with the aid of a model. An explanation is also given for the alternation of the m.p.s of chain compounds, *viz.*, the difference in the structures of odd and even substances corresponding to a difference in lattice energies, and this is reflected not only in alternations of m.p., but also for the fatty acid series in alternations of molecular volumes and of heats of crystallisation.
H. H. Ho.

2945. Organic Dipole Molecules with Single- and Double-Bonded Oxygen. K. L. Wolf. *Zeits. f. phys. Chem.* 3. *Abt. B.* 2. *pp.* 128–138, *May*, 1929.

In this paper single- and double-bonded oxygens are discussed as the moment determining parts of organic dipole molecules. With singly bound oxygen, difficulties are surmounted in the calculation of the dipole moments of disubstituted benzene derivatives by the assumption of a valency angle at the oxygen, whereby simultaneous variations in the signs of the group moments disappear. Two linkage possibilities are discussed in the case of carbonyl oxygen, and in this connection the results of measurements of the moments and ultra-violet absorption of cyclohexanone and menthone are included. Finally, the problem is examined as to how the acid character of the — OH group in the combination —COOH may be understood by means of a model. H. H. Ho.

2946. Temperature Sensitivity of the Molecular Polarisation of Gases and Vapours. R. Sänger and O. Steiger. *Helv. Phys. Acta,* 2. 2. *pp.* 136–144, 1929. *In German.*

Calculates from the dielectric constants of ethyl, methyl and propyl ether vapours, measured at constant density, that the values of their molecular electric moments are $1{\cdot}32 \pm 0{\cdot}02 \times 10^{-18}$, $1{\cdot}10 \pm 0{\cdot}02 \times 10^{-18}$ and $0{\cdot}85 \pm 0{\cdot}02 \times 10^{-18}$ respectively. These results were obtained, assuming a triangular formation of the molecule with the oxygen atom at the apex, and a comparison with previous results shows this assumption to be correct. R. C F.

2947. Mechanical Model of an Asymmetric Carbon Atom. H. G. Tanner. *J. Phys. Chem.* 33. *pp.* 755–759, *May*, 1929.

Based upon the postulate that electrodynamical asymmetry of the four valence " bonds " of the carbon atom is the fundamental cause of the optical activity of the chemically asymmetric carbon atom, a mechanically analogous model has been constructed. This mechanical " atom " rotated the plane of "plane" polarised mechanical waves, and transmitted preferentially one of the two species of circularly polarised waves.

AUTHOR.

2948. Structure of Atomic Nuclei. E. Rutherford. *Roy. Soc., Proc.* 123. *pp.* 373–390, *April* 6, 1929.

It seems possible that certain discrepancies in the estimated size of the uranium nucleus may be got over by making use of wave mechanics, as has been done by Gamow and by Gurney and Condon. The peak of the potential curve around the nucleus is in any case so high that according to classical dynamics an α-particle could not surmount it and pass outside the nucleus, for to do so it would have to have energy much greater than that observed in any α-particle. According to the wave theory, however, the wave system with which the α-particle is identified may, under certain circumstances, leak through the barrier. It was shown that, using Aston's results on the masses of the atoms, it follows that if the nuclei are regarded as built up from protons and electrons the atom is really a sink of energy, so that to take the nucleus of mercury to pieces proton by proton would require work corresponding to at least 1400 million volts. If, on the other hand, the heavier elements are regarded as being built up of helium nuclei the mass of each added α-particle in the heavier atoms is greater than that of the α-particle in the free state, and it becomes possible to account approximately for the energy emitted by radioactive elements. In the *Discussion*, it was suggested by **J. Chadwick** that the difference in the energies of the protons emitted by aluminium when bombarded by α-particles may be due to differences between the masses or internal energies of the aluminium nuclei; **C. D. Ellis** showed that information as to the nature of the nucleus can be expected from further study of the γ-rays emitted when a disintegration particle leaves the nucleus; **G. Gamow** described a wave mechanics model of an atomic nucleus, with an equation which yields "eigenwerte" giving energy and nuclear radius of the right order of magnitude. Evidence for the rotation of the nuclei was given by **O. W. Richardson. F. W. Aston, R. H. Fowler** and **D. R. Hartree** also expressed their views. H. N. A.

2949. Synthesis of the Elements. Part II. G. I. Pokrowski. *Zeits. f. Physik*, 54. 9–10. *pp.* 724–730, 1929.

Continues the theoretical treatment of the union of protons and electrons, and, on certain assumptions, obtains an expression for ΔH. A table gives the value of ΔH for a number of elements obtained from this formula, with Aston's values for the same quantity; also the atomic weights according to the theory and those found by Aston. Certain deductions are made as to the values of X, the distance from the nucleus to which a proton must be brought in order that union may take place for different nuclei. The author concludes that, to a first approximation, his calculations agree with experiment. Discusses the thickness of the layer in space which emits the cosmic rays. He obtains a radius of 12×10^{20} cm., or about 400 parsecs, which is of the same order as that which astronomers have deduced for the dimensions of the stellar system. H. N. A

2950. Configuration of Quadrivalent Atoms. T. M. Lowry. *Cambridge Phil. Soc., Proc.* 25. *pp.* 219–221, *April*, 1929.

Discusses the alternative views which have been put forward as to the configuration of quadrivalent atoms. A number of compounds of Pt, Co, Ni, Te, Sn, Zn, Cd, Hg and Pd are considered. Points out that the problem has been solved by the X-ray analysis of crystals of different types. Dickenson has assigned a *tetrahedral* configuration to the anions in the *cubic* crystals of K$_2$[ZnC$_4$N$_4$), K$_2$[CdC$_4$N$_4$) and K$_2$[HgC$_4$N$_4$], and a *planar* configuration to the anions in the *tetragonal* crystals of K$_2$[PtCl$_4$], K$_2$[PdCl$_4$] and Am$_2$[PdCl$_4$]. The change in the crystallographic system clearly indicates a difference in the configuration of the complexes [MA$_4$]$^{--}$ in the two series. H. N. A.

2951. Spectral Relations between Certain Iso-Electronic Systems and Sequences. Part. II. Sc I, Ti II, V III, Cr IV and Mn V. H. E. White. *Phys. Rev.* 33. *pp.* 672–683, *May,* 1929.

The methods described in a previous paper [see Abstract 2680 (1929)] are applied to the spectra of the iso-electronic sequence named above. Tables of terms and radiated frequencies are given for V III, Cr IV and Mn V. "Ionisation" potentials for these systems are determined at 29·6, 50·4 and 75·7 volts respectively. W. S. S.

2952. Assignment of Quantum Numbers for Electrons in Molecules. Part III. Diatomic Hydrides. R. S. Mulliken. *Phys. Rev.* 33. *pp.* 730–747, *May,* 1929.

Since the first papers appeared [see Abstracts 63 and 1053 (1929)], Hund has published a paper [see Abstract 705 (1929)] on similar lines, and including the case of diatomic hydrides. The known electronic states are derivable from unexcited H plus familiar low-energy states of M atoms. The following effects are indicated: (1) the couplings between l_r vectors of M atom outer electrons are broken down; (2) the uncoupled vectors l_r are separately space-quantised with reference to the electric axis; (3) the electron of the H atom is promoted, and takes its place with the M electrons, the H nucleus remaining outside the M electron cloud; (4) the original s_r vector couplings are broken down by H electron spin. Data are presented as evidence that molecular stability is primarily a matter of promotion energy rather than of valence bonds, and a simple explanation is given of multiple widths of $\Delta\nu$ in $^2\pi$ and $^3\pi$ states of MH molecules in terms of $\Delta\nu$ values of the M atom. F. S.

2953. Predissociation and Diffuse Spectra. O. K. Rice. *Phys. Rev.* 33. *pp.* 748–759, *May,* 1929.

The width of rotation lines is calculated by wave mechanics. The extra terms in the exact wave equation are treated as a perturbation, and the perturbed eigenfunctions expressed as a linear function of the unperturbed ones. The energy range over which the properties of a given discrete state may influence the properties of the perturbed eigenfunctions is determined in terms of the perturbation matrix components, and from this is found the width of the line and the total absorption over its width. F. S.

2954. Expression for Natural Rotation Corresponding to Molecular Refraction. K. L. Wolf and H. Volkmann. *Zeits. f. phys. Chem.* 3. *Abt. B.* 2. *pp.* 139–148, *May,* 1929.

Gaus deduced on the grounds of the Born theory [see Abstract 934 (1918)] an expression for the natural rotation having a similar significance as the specific refraction has for refraction. The dependence of rotation on the refractive index was confirmed by measurements of Wetterfors as well as by the present measurements of limonene and its solutions.

Deviations were shown to occur due to dipolar effects and to molecular association as shown and confirmed by measurements on menthone and carvone and their solutions. The dipol moment for menthone has been determined as $2 \cdot 77 \, . \, 10^{-18}$, while for limonene the highest value is only $0 \cdot 5 \, . \, 10^{-18}$. The absorption curves for ultra-violet light for $0 \cdot 14$ mol. solutions of methone in hexane and absolute methyl alcohol are also given. J. K.

2955. Method of Deviation of Molecular Rays. I. I. Rabi. *Zeits. f. Physik*, 54. 3–4. *pp.* 190–197, 1929.

The use of this method has hitherto involved an exact knowledge of the magnetic deviating field and of its inhomogeneity. As now worked out, from the energy difference of the molecules in the field, field strengths are measured instead of their rate of change with distance. The method may be applied to the measurement of magnetic and electric molecular moments. It was tested experimentally by measuring the magnetic moment of the potassium atom, which was found to be that of the Bohr magneton to within 5 %. G. E. A.

2956. Analogy for Beams of Particles of a Reciprocal Optical Theorem due to Helmholz. R. H. Fowler. *Cambridge Phil. Soc., Proc.* 25. *pp.* 193–197, *April,* 1929.

The optical theorem states that if a ray (1) after any number of reflections or refractions at plane, or nearly plane, surfaces gives rise (among others) to a ray (2) whose intensity is a certain fraction f_{12} of the intensity of ray (1), then on reversing the direction of the light an incident ray (2)′ will give rise (among others) to a ray (1)′ whose intensity is a fraction f_{21} of the ray (2)′, such that $f_{12} = f_{21}$. It is shown that an analogous theorem holds for beams of electrons transmitted or reflected at plane potential "hills" in accordance with Schrödinger wave mechanics. The result is established directly using the wave equation. It is shown to follow also from the principle of detailed balancing for an assembly in statistical equilibrium. W. S. S.

2957. Quantum Mechanics of Many-Electron Systems. P. A. M. Dirac. *Roy. Soc., Proc.* 123. *pp.* 714–733, *April* 6, 1929.

A mathematical paper showing how to translate the methods and results of group theory into the language of quantum mechanics. A formula is arrived at which, combined with Hartree's method for determining approximate wave-functions for the different electrons, should provide a powerful way of dealing with complicated atomic systems. A. D.

2958. Relativistic Theory of an Atom with Many Electrons. J. A. Gaunt. *Roy. Soc., Proc.* 124. *pp.* 163–176, *May* 2, 1929.

The ordinary classification of multiplets and the selection and summation rules are derived from Dirac's relativistic wave equation. It is shown that (*a*) the selection rules are rigorous if there are no external fields, (*b*) the rule "$\Delta\Sigma k$ is odd" (k = azimuthal quantum number for a single electron, Σ extends over all the orbits involved in a given state), is equally rigorous, even in a uniform magnetic field, (*c*) the summation rule holds if magnitudes of the order of the spin energy are neglected. W S. S.

2959. Quantum Mechanics. *Frank. Inst., J.* 207. *pp.* 449–542, *April,* 1929.

A Symposium on Quantum Mechanics at the American Physical Society, Dec. 31, 1928, comprising the following fourteen papers: "Physical

Meaning of Wave Mechanics," by **J. C. Slater**; "Wave Mechanics," by **W. F. G. Swann**; "The Operator H in Schrödinger's Equation," by **F. D. Murnaghan**; "Quantum Mechanics of Momentum Space," by **E. U. Condon**; "Statistical Interpretation of Various Formulations of Quantum Mechanics," by **J. H. van Vleck**, *Discussion* by **D. J. Struik** and **M. S. Vallarta**; "Uses and Defects of the Wave Equation," by **E. H. Kennard**; "Pendulum Problem in the Wave Mechanics," by **E. C. Kemble**; "Problem of Symmetry in Quantum Mechanics," by **H. Weyl**; "Rôle of Groups in a Physical Theory," by **G. Y. Rainich**; "Quantum Mechanics," by **S. A. Goudsmit**; "Harmonic Analysis and the Quantum Theory," by **N. Wiener**, *Discussion* by **H. P. Robertson**; and "Kinetic Method in Statistical Mechanics," by **G. E. Uhlenbeck.**

2960. Possible Geometrical Signification of Relativistic Quantum Theory. V. Fock and D. Iwanenko. *Zeits. f. Physik*, 54. 11–12. *pp.* 798–802, 1929.

The form of Dirac's wave equations suggests the use of a linear expression $ds = \sum_{i=1}^{4} \gamma_i dx_i$ for the line element on which to base the geometrical theory, where the γ_i's are the four-row matrices of Dirac. Dividing by $d\tau$, the differential of the proper time, a "linear geometric" expression is obtained for the velocity four-vector: $\frac{ds}{d\tau} = \sum_i \gamma_i v_i$. For the v_i's the quantum theory operators $\frac{1}{m}\left(p_i + \frac{e}{c}\mathrm{A}_i\right) = \frac{1}{m}\left(\frac{h}{2\pi i}\frac{\partial}{\partial x_i} + \frac{e}{c}\mathrm{A}_i\right)$ are substituted, and for $\frac{ds}{d\tau}$ the corresponding classical magnitude—the absolute value of the four-velocity—equals c. Thus the wave equation obtained by operating on ψ runs $\frac{1}{m}\sum_{i=1}^{4} \gamma_i\left(p_i + \frac{e}{c}\mathrm{A}_i\right)\psi = c\psi$, which is Dirac's result. The geometrical significance of these formal steps is discussed. The ideas can be extended to general relativity, variable matrices γ, then being used. A connection with Einstein's new field theory is pointed out.

W. S. S.

2961. Causality in Quantum Mechanics. G. W. Kellner. *Zeits. f. Physik*, 55. 1. *pp.* 44–51, 1929.

According to Schrödinger an electron consists of an extended, non-rigid configuration, the form and magnitude of which is determined by the surrounding field; in certain measurements, however, the position of an electron is definite, and this implies that the wave function ψ is made to run together by the action of an external electromagnetic field introduced for this purpose. An imaginary experiment is described, which shows that such a concentration is theoretically possible, and from this the author finds the condition for obtaining a measurement, which is as accurate as one carried out with an infinitely small test body. Theoretically, then, it is possible to apply causally determined laws to the calculation of the motion of an electron, when the Schrödinger theory is employed; but in practice it is not possible to employ the "infinitely small test body test," and it becomes necessary, as in the case of the kinetic theory of gases, to calculate from initial states which are not accurately known, and to employ the statistical method. This method does not, however, exclude the law of causality. H. N. A.

2962. Fundamentals of Analytical Mechanics as Basis of Quantum and Wave Mechanics. P. Frank. *Phys. Zeits.* 30. *pp.* 209–228, *April* 15, 1929.

The advent of quantum mechanics has elevated to a position of prime importance certain functions, and points of view which, although they already existed in classical analytical mechanics, were regarded as mere mathematical jugglery (Spielerei). Examples: Poisson bracket expression, theory of contact transformations. The present work gives an account of analytical mechanics introducing and stressing just those aspects which are vital for the subsequent introduction of the quantum mechanics. The development is extended to cover Schrödinger's wave equation and the solution of the case of a three-dimensional harmonic oscillator. W. S. S.

2963. First and Second Order Equations of the Quantum Theory. H. T. Flint. *Roy. Soc., Proc.* 124. *pp.* 143–150, *May* 2, 1929.

The analogy between Dirac's first order wave equations and Maxwell's electromagnetic equations is developed. In the theory of relativity electromagnetic phenomena are described in terms of an antisymmetric tensor F. In the present discussion a five-dimensional continuum is employed, and it is shown that equations similar to the generalised Maxwell's equations, but involving two covarient tensors F and G, which are not antisymmetric, can be laid down which lead ultimately to Dirac's equations in the form given by Darwin. If F and G were antisymmetric, certain terms associated with *mc* would be missing from the final result. These terms can only be introduced by including them in an operator as Darwin or Frenckel do, or by letting F and G contain symmetric components as is done here. The present equations in the case of a preponderating electromagnetic field (negligible gravitational field) lead to the same second order wave equation as obtained by operational methods.

W. S. S.

2964. Perturbation Theory in Quantum Mechanics. II. A. H. Wilson. *Roy. Soc., Proc.* 124. *pp.* 176–188, *May* 2, 1929.

The perturbation theory is discussed for systems with both discrete and continuous spectra. The Hamiltonian H of the perturbed system is split up into three parts, H_0, H_1 and $H_2(t)$, two of which can be chosen arbitrarily. The solutions of the perturbed problems can then be worked out in terms of the characteristic functions corresponding to the Hamiltonian $H_0 + H_2(T)$, where T is any arbitrary fixed time. An alternative method is to regard the motion as a perturbation on that Hamiltonian which most corresponds to the experimental conditions. This criterion, together with the original conditions, suffices to fix the division of H into the three parts which at first were chosen arbitrarily. E. E. F. d'A.

2965. New Quantum Theory. R. Zaycoff. *Zeits. f. Physik*, 54. 7–8. *pp.* 588–589, 1929.

The field equations of the new quantum theory developed by Whittaker [see Abstract 1062 (1929)] are deduced. Dirac's wave equations can be derived by appropriate combination of the field equations. The theory is an extension of Schrödinger's theory. J. S. G. T.

2966. Relativity Precession. L. Page. *Phys. Rev.* **33.** *pp.* **572–583,** *April,* 1929.

An expression has been deduced for the time rate of change of a vector relative to a basic inertial system S in terms of the time rate of change of the vector relative to the inertial system S′ in which its origin is momentarily at rest. Assuming the vector to remain constant in direction and magnitude relative to the system in which its origin is momentarily at rest, the change of the vector relative to the basic inertial system has been investigated under the following headings: (*a*) deformation of a small closed surface; (*b*) vector moving in a plane; (*c*) motion in a circle; (*d*) classical Keplerian motion; (*e*) relativity Keplerian motion; particular attention being paid to the mean rate of precession of the vector. Assuming the vector to have an angular velocity without change of magnitude relative to the inertial system in which its origin is momentarily at rest, the angular velocity and rate of change of magnitude relative to the basic inertial system have been calculated. As a check on the formula the angular velocity of the lines of force of a moving point charge has been computed. AUTHOR.

2967. Axioms of Five-Dimensional Relativity Theory. H. Mandel. *Zeits. f. Physik,* 54. 7–8. *pp.* 564–566, 1929.

The five-dimensional basis of the unified field theory is investigated and generalised. J. S. G. T.

2968. Basis of A. Einstein's New Field Theory. R. Zaycoff. *Zeits. f. Physik,* 54. 7–8. *pp.* 590–593, 1929.

The author shows how the identities developed in a previous paper [see Abstract 2118 (1929)] are to be transformed in order to obtain the fundamental equations of the theory, the equations of the gravitational field, and equations analogous to the wave equations of the quantum theory. J. S. G. T.

2969. Basis of Einstein's New Field Theory. R. Zaycoff. *Zeits. f. Physik,* 54. 9–10. *pp.* 738–740, 1929.

The compatibility of Einstein's twenty fundamental equations with the identities of the author's theory [see preceding Abstract] is discussed. J. S. G. T.

2970. Historical Introduction to Einstein's Relativity. G. Polvani. *Elettrotecnica,* 16. *pp.* 360–366, *May* 25, 385–390, and *pp. June* 5, 1929.

Gives an analysis of relevant discussions from classical till recent times. Quotes a letter of Clerk Maxwell published in *Nature* on January 29, 1880, which anticipates the Michelson-Morley experiment, but declares the effect to be beyond the limits of measurement. E. E. F. d'A.

2971. Geometrical Aspect of the Lorentz Contraction. J. B. Pomey. *Annales des P.T.T.* 18. *pp.* 452–457, *May,* 1929.

The fundamentals of the special relativity theory are interpreted by reference to the geometry of the hyperbola. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

2972. Observations and Investigations at the Blue Hill Meteorological Observatory in 1928. A. McAdie. *Blue Hill Meteorolog. Obs.* [29 *pp.*], 1929.

Observations for 1928 are used in extending the tables given earlier [see Abstract 1850 (1928)]. In an introductory note the author discusses the adoption of a new system of units for pressure, temperature and related quantities. In some detail the danger to aircraft arising from fog, supercooled cloud droplets, the violent vertical air currents met with near thunderstorms and from lightning discharge is examined and the means by which these troubles may be avoided. R. S. R.

2973. Rate of Ascent of Pilot Balloons at Melbourne. E. Kidson and H. M. Treloar. *Roy. Meteorolog. Soc., J.* 55. *pp.* 153–168, *April,* 1929.

Paper balloons calculated to ascend 100 metres in 45 minutes according to Dines' formula ($V = qL^{\frac{1}{2}}/(W + L)^{\frac{1}{3}}$; $q = 84$) were used and their positions observed at the times they should by the above formula have reached 100, 200, . . . 1100 metres. Up to 200 m. the mean rate of ascent was greater, above that height less than given by the formula. The mean rate is highest in summer, lowest in winter, but is very variable. A series of standard deviations is given. Turbulence, especially that due to heat, is the most important factor in increasing the rate of ascent, but is probably of less influence in this respect in stable than in unstable air. Many tables and curves are given. C. A. S.

2974. Dynamics of Anisobaric Movements at Surfaces of Discontinuity. R. Becker. *Gerlands Beitr. z. Geophys.* 21. 1. *pp.* 1–32, 1929.

The conditions of equilibrium for two air masses of different temperatures meeting along an inclined plane are obtained and it is found that (1) the Margules-Stuve formula holds only near to the boundary regions and cannot be stated from conditions existing in other parts, and (2) this formula is only one condition for equilibrium and others are needed, *e.g.*, when accelerations exist whose magnitudes are proportional to the potential temperatures above and below the plane. By establishing equations for these accelerations at the surface of discontinuity, the author finds that the movements are of a wave form, the two air masses moving in opposite directions on cycloidal paths. The period is of the order of several hours and the wave-length several hundred km. Treating the equation of continuity qualitatively, it is found that shortened cycloids are required. When allowance is made for the effect of the earth's surface, it is stated that this discontinuity loses its character of a plane and extends into a wave form. Two examples of weather charts for North-West Europe are used to illustrate these facts. It is shown that a period of cold produced by stratospheric changes usually causes an anticlockwise rotation of the wind, while a decrease of cold causes the reverse. Possible practical applications of the above are shown. R. S. R.

2975. Friction and Surfaces of Discontinuity. R. Becker. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 162–172, 1929.

Employing the hydrodynamical equations of motion for an infinite plane, the wind velocity is calculated as a function of the distance from the plane in the case when frictional equilibrium exists. It is assumed that in warm and cold air masses a virtual internal friction is present and that at the surface of discontinuity of the two air masses surface friction takes place. This relation for wind velocity is shown as a vector diagram and consists of two logarithmic spirals. At increasing distance from the surface the wind velocity converges to the isobaric value. It is found that under these conditions there must be upward sliding along the surface of discontinuity. In a numerical example, by making certain assumptions regarding the coefficient of friction, the order of magnitude of the vertical movement is found to be such that it can play a part in the occurrence of the condensation processes. R. S. R.

2976. Dew. N. Critikos. *Gerlands Beitr. z. Geophys.* 21. 1. *pp.* 33–35, 1929.

Observations on the formation of dew show, contrary to the general opinion, that dewdrops originate in the air-layer above the earth's surface and not on the exposed objects themselves. The dewdrops are of larger diameter than water particles in fog or cloud. Drops are formed only in the layer very close to the earth's surface. The drops fall singly upon the surface. The size and number of the drops falling on unit surface in unit time depend upon the rapidity of cooling W. A. R.

2977. Transfer of Heat by Radiation and Turbulence in the Lower Atmosphere. D. Brunt. *Roy. Soc., Proc.* 124. *pp.* 201–218, *May* 2, 1929.

A simplifying assumption respecting the nature and extent of the effects of radiation and absorption by water-vapour in the atmosphere, based on Hettner's measurements of absorption by water-vapour, has enabled the reduction of the problem of the transfer of heat by radiation and absorption to a tractable form. This transfer is found to be analogous to the conduction of heat in a solid, the ordinary coefficient of molecular conductivity being replaced by a much larger coefficient, the radiative diffusivity K_R. The transfer of heat by eddies in a turbulent atmosphere is evaluated for a compressible atmosphere, and it is shown that the eddy flux of heat is proportional to the difference between the lapse rate and the adiabatic, and to the eddy-diffusivity K, defined by Taylor. The relative magnitudes of K_R and K are considered. K is normally of the order of 10^3 in inversions, but is usually greater than 10^5 when the atmosphere is fairly turbulent. Both radiation and turbulence tend to smooth out any bends in a temperature height curve. H. H. Ho.

2978. Calculation of Maximum Sunshine Duration with an Irregular Horizon. V. Conrad. *Gerlands Beitr. z. Geophys.* 21. 4. *pp.* 366–372, 1929.

The author shows that for mountain valley stations the total sunshine registration on cloudless days, or the possible duration on days which are cloudless at sunrise and sunset, gives a fair representation of the horizon. This is set out graphically for Gargellen (Vorarlberg), with periods of ten days throughout the year, and from the curve the maximum sunshine duration can be established. R. S. R.

2979. Method of Showing the Dependence of Ocean Currents on the Trade Winds, and the Rôle of these Currents in Changing the Climate in Geological Epochs. P. Lasareff. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 215–233, 1929. *In French.*

In a circular or rectangular dish, models of the continents (to plane, or Mercator's projection, respectively) are surrounded with water, and the trade winds simulated by a ring or rows of nozzles discharging air in the correct directions just above the surface. The ocean currents for the present land-water distribution are in good agreement with the actual ones, and so it is concluded that those for past epochs when this distribution was very different can be found at least in their main features; by means of an electrically-heated wire at the Equator, temperature effects can be studied. Results are shown for various conjectured continent-sea distributions in various geologic periods, which seem to explain the large-scale variations of climate which the Northern Hemisphere has certainly experienced. W. G. B.

2980. Internal Friction in Certain Tidal Currents. S. F. Grace. *Roy. Soc., Proc.* 124. *pp.* 150–163, *May* 2, 1929.

In deriving general equations the motion is discussed in a restricted region for which the mean surface of the sea is assumed to be a horizontal plane. The observations at the North Sea stations having given currents at various depths, these have been analysed into their harmonic constituents and the values at the surface and bottom found by extrapolation. Data with diagrams are given for the Sound of Jura, the Solent, and North Sea stations. The results refer to the principal lunar semi-diurnal tidal motions existing at the various stations. H. H. Ho.

2981. Tidal Currents. H. Thorade. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 290–312, 1929.

Tidal currents may be considered as due to the combined effects of tidal forces, earth friction and earth rotation. The problem is best dealt with by dividing the calculation into two parts. Firstly, the effects of tidal force combined with earth friction are calculated giving the "nullstream." Under the same conditions the nullstream is stronger under right-handed than under left-handed forces. Secondly, the combined effects of earth friction and rotation are considered giving the "differential stream." A combination of the "null" and "differential" streams gives the resultant tidal current. Instead of using rectangular coordinates the problem is handled by splitting the periodic currents into two circular components. W. A. R.

2982. Isostasy and Moments of Inertia. F. Hopfner. *Gerlands Beitr. z. Geophys.* 21. 1. *pp.* 103–111, 1929.

Displacements of mass by isostatic reduction are shown to produce considerable displacement of the principal axes of inertia in the equatorial plane. The amount of this displacement cannot, however, be calculated with any accuracy. W. A. R.

2983. Isostasy. A. Belluigi. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 173–177, 1929. *In Italian.*

The general case for topographic adjustment is worked out for a column of varying density. Then follows a development of the formula for deep-seated masses. W. A. R.

2984. Wegener's Continental Drift. H. Stölting. *Gerlands Beitr. z. Geophys.* 21. 1. *pp.* 112–115, 1929.

Considerable light is thrown upon the theory of Continental drift if the chief cause of the movement is considered to be the Sima (the lower, basic, heavier layer of the earth's crust) rather than the Sial (the upper, siliceous, lighter stratum). Simple experiments show that the upward movement of a cork in pitch is produced by the outward flow of material from *above* it and an inward flow of material *below* it. The effect is that of suction above combined with pressure below. Continental drift is due, then, to differential adjustment of the heavier layer under rotational forces. The paper shows how readily this view can be applied to the distribution of various land masses on the earth's surface. W. A. R.

2985. Deformation of Earth's Crust. J. Geszti. *Gerlands Beitr. z. Geophys.* 21. 1. *pp.* 36–78, 1929.

The earth's crust is assumed to be in a plastic state under the high-pressure conditions that exist. On the results of T. v. Karman's experiments, rocks are assumed to follow the same laws as the plastic deformation of metals. Plastic deformation is applied to explain the great folded masses of the earth's crust and the elevations of folded mountains. The distribution of forces producing tangential strain is discussed, and these attain their maximum at the line where plastic deformation begins. The problem of cooling contraction is reconsidered from the standpoint of the constant-volume conditions attending the deformation of solids; an acceptable value for the probable mean cooling of the earth that has taken place since the formation of alpine mountains is reached. The mechanical transformation of the earth's surface is discussed. W. A. R.

2986. Potential Distribution around Various Bodies in a Homogeneous Electric Field. J. N. Hummel. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 204–214, 1929.

The author deals with the distribution of potential around bodies of different shape when they are embedded in homogeneous isotropic mother rock and surrounded by a homogeneous stationary electric field. The case of cylindrical bodies with the axis parallel to the current direction is especially considered as this can be compared with that for strata or veins. The method employed is one of repeated test by troughs and crests to get the required shape. For such an extraneous body of definite shape, occurring at a known depth below the earth's surface, the potential at the earth's surface can be calculated exactly and the corresponding potential field delineated. R. S. R.

2987. Quantitative Electromagnetic Apparatus for Determining the Depth and Occurrence of Lodes from the Surface. M. Müller. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 234–269, 1929.

Alternating current was supplied to two electrodes some distance (405 m.) apart, in a region whose geology was known, and the surface magnetic field mapped. Theoretical distributions for various subterranean conductors are given, and the results interpreted from these. The agreement between the expectations from the known geology and the results is good. The apparatus used is described. W. G. B.

ASTROPHYSICS.

2988. Distribution of Coronal Light. H. T. Stetson and L. B. Andrews. *Astrophys. J.* 69. *pp.* 227–236, *April*, 1929.

The results of a photometric study of standardised coronal plates taken at the Sumatra eclipse of January 14, 1926, indicate a diminution of brightness in the solar corona which cannot be expressed as a simple function of the radial distance either from the limb or the sun's centre. Exponential formulæ, however, have been found which will represent, satisfactorily, the diminishing brightness with increasing distance from the solar centre. These are as follows: For the region of 2·0–2·55 solar radii from the centre, $L \propto \rho^{-7}$; from 2·55 to 3·1 radii, $L \propto \rho^{-4}$; from 3·1 to the limit of measurement, $L \propto \rho^{-2}$; where L equals the illumination seen from the earth, ρ = the radial distance from the sun's centre in terms of the sun's radius as a unit. A composite curve is drawn, giving the combined results of observation at several eclipses. Discrepancies in the results of different investigations are largely due to the difference in the regions analysed. There is little evidence that the laws of distribution of brightness vary appreciably at different eclipses. AUTHORS.

2989. Argon in the Corona. H. N. Russell and I. S. Bowen. *Mt. Wilson Observat. Contrib. No.* 375. *Astrophys. J.* 69. *pp.* 196–208, *April,* 1929.

A critical study of the coincidences between the lines in the spectrum of the solar corona and in that of argon, which have recently been suggested by I. M. Freeman [see Abstract 1088 (1929)] shows (*a*) that the number of these coincidences is little larger than might be expected from pure chance, within the very wide limits of error which have been admitted; (*b*) that the discordances for the better measured lines greatly exceed the limits of observational error; and (*c*) that the suggested coincidences are with weak or forbidden lines, while far stronger argon lines, which should be much more persistent, are absent. This cumulative evidence shows decisively that the attribution of the coronal lines to argon is without foundation. Formulæ for computing the number of chance coincidences between spectra are given and tested empirically by comparison with fictitious lines chosen at random. AUTHORS.

2990. Electromagnetic Effect of Importance in Solar and Terrestrial Magnetism. R. Gunn. *Phys. Rev.* 33. *pp.* 832–836, *May,* 1929.

The thermal motions of ions in an inhomogeneous magnetic field give rise to a systematic ion drift. A study of the motion of ions executing long free paths and spiralling about an inhomogeneous impressed magnetic field has shown that a systematic drift is imposed which is oppositely directed for the positive and negative ions. The resulting drift velocity is proportional to the component of the magnetic gradient that is perpendicular to the magnetic field itself. Under the conditions of radial symmetry and a closed circuit a current flows which is in such a direction as to reduce the inhomogeneity of the impressed field and increase the total flux enclosed by the current circuit. This increase in the flux enclosed by the circuit shows that the phenomena may be regenerative. Certain applications to the sun's atmosphere, sunspots and the permanent magnetic field of the sun and earth are suggested. AUTHOR.

2991. Theory of a Metric Terrestrial Planisphere. A. Cabreira. *Comptes Rendus,* 188. *pp.* 1034–1035, *April* 15, 1929.

Since any meridian is elliptical in form, the length of a degree on the earth's surface increases with latitude. The author obtains numerically corrections to the respective arcs and for an arc of latitude between any point and the meridian at the origin in terms of the geographical coordinates of this point and the radii of the earth at equator and pole. A diagrammatic representation of these relations is described. R. S. R.

2992. Relation of Aberration Phenomena to the Theory of Relativity. G. v. Gleich. *Zeits. f. Physik,* 55. 1. *pp.* 65–80, 1929.

Planetary and stellar aberration are not, in principle, to be distinguished from one another. Their solution is a purely kinematic problem. The relativistic and classical theories of aberration are compared, and deductions relating to double and variable stars are briefly discussed. Consequences of assuming that the velocity of light is not constant throughout space are referred to. J. S. G. T.

2993. Absorption Bands in Stellar Spectra. R. Wildt. *Zeits. f. Physik*, 54. 11–12. *pp*. 856–879, 1929.

Stellar spectra of the late types G to M, S and R to N show many bands of absorption, due to molecular combinations, but few of these have so far been identified. Only four oxides and three carbon compounds are recognised with certainty in the stars, and four hydrides in the sun, especially in sunspots. The extent of stellar spectra accessible to observation is limited by the selective transparency of our atmosphere, the sensitiveness of plates to different regions, the small dispersion generally used, and above all, the overlapping of bands. The conditions under which various molecular combinations might be expected to be present in stars, and to betray their presence in their spectra, are discussed from the thermochemical and the spectroscopic points of view. M. A. E.

2994. Cepheid Variables. H. Ludendorff. *Preuss. Akad. Wiss. Berlin, Ber*. 5. *pp*. 64–95, 1929.

The long-period Cepheids fall into two distinct groups, according to form of light-curve. Those of Group I, with periods longer than nine days, resemble Mira variables of the Me type in several important features: thus, there is frequently a pause on the ascending, but never on the descending curve, stars with the longest periods and most nearly symmetrical light-curves have the sharpest maxima, and the rise never lasts longer than the fall. In fact, this group, although differing in some ways from Me variables, has such astonishing resemblances in the relation of light-curve to period that the suggestion of a common cause for variability (which has been suggested before) is distinctly confirmed.

Group II, on the other hand, which comprises long-period Cepheids of period usually less than nine days, shows no pause on the ascending but frequently on the descending curve, and the position of the pause is strictly related to the length of the period, being further from the maximum and also less marked as the period is shorter. The short-period Cepheids, with periods less than a day, resemble Group II in the position of the pause and its relation to length of period, but here there are often *two* pauses in the descent; also there is often a flat minimum, which seldom occurs and never in a marked degree among the long-period Cepheids of Groups I and II.

It is desirable to have more data of Cepheids, especially those with periods over 10 days, before discussing the probable causes of variation, and whether the separation into two groups has any bearing on the law of luminosity-period. M. A. E.

2995. Radial Velocity of the Cluster-Type Variable RR Lyræ. R. F. Sanford. *Astrophys. J*. 69. *pp*. 240–241, *April*, 1929.

The elements derived in Mount Wilson Contribution No. 3511 harmonise the epoch of light maximum and velocity minimum used in that investigation, but do not satisfactorily represent later photometric data which were overlooked. All light maxima and velocity minima, however, are cared for by a formula developed by Prager. This formula is, therefore, to be used in preference to the author's. AUTHOR.

LIGHT.

2996. Lens Capsule in Eye-Accommodation. E. F. Fincham. *Optical Soc., Trans.* 30. 3. *pp.* 101–117, 1928–1929.

In primates the anterior surface of the lens assumes a somewhat conical form when the suspensions are severed. The capsule of the primate lens has a zone of increased thickness surrounding a central thin area. A monkey's lens removed from the eye is in the typical accommodation form; without its capsule the lens presents a close approach to the unaccommodated form. The anterior lens capsule of animals of an order lower than the primates is approximately uniform in thickness, and the conical form does not appear in these cases. Theory that accommodation consists of a relaxation of tension upon the lens by the contraction of the ciliary muscle, as stated by Helmholtz; this relaxation allows the capsule to press upon the lens substance and mould it into the accommodated form. In the unaccommodated state the tension under which the lens is held by its supporting fibres does not permit this compression; the unaccommodated lens substance is therefore in its unrestricted or natural form and not under compression as supposed in the Helmholtz theory. A. D.

2997. Transparency of Thin Metallic Films for Long-Wave Infra-Red Radiation in Relation to the Electrical Conductivity. H. Murmann. *Zeits. f. Physik*, 54. 11–12. *pp.* 741–760, 1929.

Deduces from Maxwell's theory a formula which makes the transparency independent of the wave-length, so that it depends only on the product of the thickness and electrical conductivity of the film. Describes experiments in which the percentages of infra-red rays of different wave-lengths, ranging from 25μ to 110μ, which passed through thin films of different thicknesses of silver, bismuth and antimony, were measured with a microradiometer; the correctness of the formula was confirmed. No alteration in the transparency for wave-lengths corresponding to the characteristic vibrations of the metals in the infra-red was observed. The theoretical relation still holds when, owing to the thinness of the films, the electrical conductivity has an abnormal value. In the case of antimony, two modifications were observed, with different electrical conductivities, and the existence of similar modifications in silver was confirmed. H. N. A.

2998. Horizontal Rainbow. W. J. Humphreys. *Frank. Inst. J.* 207. *pp.* 661–664, *May*, 1929.

The author describes an unusual rainbow complex seen on Lake Monroe, Florida, following a fog. It comprised a primary bow, a secondary bow and a reflected primary. He considers these horizontal rainbows are caused by either a layer of droplets floating in the air just above the surface or a sheet of droplets, probably of drizzle size, usually resting on an oil film which keeps them from merging with the water beneath. An explanation of their formation is given and the shapes assumed for different elevations of the sun. R. S. R.

2999. Refractive Index of Sodium Vapour and Width of D_1 in Absorption. S. A. Korff. *Phys. Rev.* 33. *pp.* 584–588, *April*, 1929.

Continuing the study by Stewart and Korff [see Abstract 451 (1929)] of the refractive index of sodium vapour near the D lines, more accurate measurements are obtained. The variation of the refractive index is found to agree with the classical formulæ, within small experimental errors. Similarly, the relation of the dispersion to the width of the D lines in absorption, measured visually, is found to agree with that predicted classically. By these purely optical methods a value of the "radius" of the electron can be found. It is in order of magnitude 10^{-13} cm. Further study, employing a densitometer, will be necessary to determine an exact value. AUTHOR.

3000. Refractivity of Gaseous Compounds. G. W. Brindley. *Phil. Mag.* 7. *pp.* 891–897, *May*, 1929.

The refractivity of a substance is usually defined as $(\mu^2 - 1)/(\mu^2 + 2)$ for theoretical reasons, but for gases, with which $\mu - 1$ is small compared with unity, it is justifiable to use $\mu - 1$ as a measure of the refractivity. For the substances here considered, the experimental values of the refractivities have been reduced to the values they would have had if the number of molecules per cubic centimetre of the gas or vapour had been equal to the number of molecules per cubic centimetre of hydrogen at 0° and 760 mm. pressure [see Cuthbertson, Abstract 1064 (1920)]. If $R(\chi)$ denotes values of $(\mu - 1)$ so corrected, $R(HCl) = \frac{4}{7}R(Cl_2)$, $R(CCl_4) = \frac{16}{7}R(Cl_2)$, $R(HBr) = R(Br_2)$, and $R(CS_2) = \frac{4}{3}R(S_2)$. A tentative explanation is given based on the numbers of loosely bound electrons, and it is shown that, if certain conditions are approximately satisfied, such simple relations might be expected both from the quantum theory and also from the classical theory of dispersion. It is realised that a simple explanation of this kind cannot be final, and a more detailed explanation is required which will be applicable in the general case. T. H. P.

3001. Alteration of the Frequency of Light through Variation of the Optical Path. S. Levy. *Zeits. f. Physik,* 54. 9–10. *pp.* 674–675, 1929.

Discusses the influence of a path which alters with the time on the frequency of the light. The variation in the path can be realised with a Kerr cell, with a voltage which varies with the time. The frequency difference produced between the two polarised components into which the light is divided by the Kerr cell is deduced. H. N. A.

3002. Graphical Treatment of Fresnel's Formula (Case of Refraction). G. Krompholz. *Phys. Zeits.* 30. *p.* 251, *May* 1, 1929.

The author gives a graphical method for obtaining the amplitude of the refracted ray in terms of that for the incident ray with varying angles of incidence, a result only obtained with difficulty by an analytical method. R. S. R.

3003. Double Refraction of Stretched Rubber. W. C. van Geel and J. G. Eymers. *Zeits. f. phys. Chem.* 3. *Abt. B.* 3. *pp.* 240–246, *May*, 1929.

A distinction is drawn between unvulcanised plastic rubber and elastic rubber obtained by drying latex. The former, except under very slight loads, does not reach a steady length under a given load and further, on removal of the load does not regain its original length. The double refraction of this rubber is a linear function of the load except for small loads, at which it still retains some elastic properties. For elastic rubber this proportionality between double refraction and load is only obtained at high loads when the extension is greater than 70 %. Under smaller loads the relation between double refraction and load is given by the equation $\Delta\epsilon = A(1 - 3/b \coth b + 3/b^2)$, where $\Delta\epsilon$ is the change in double refraction and b is the load. This equation was developed by Ornstein to express the influence of a magnetic field on the double refraction of liquid crystals. It is further noteworthy that X-ray evidence shows that at a 70 % extension in length, rubber begins to become fibrous in structure. F. J. W.

3004. Dispersion of Double Refraction in Quartz. T. H. Havelock. *Roy. Soc., Proc.* 124. *pp.* 46–49, *May* 2, 1929.

The paper forms an extension of an earlier paper by the author [see Abstract 235 (1908)]. In the expression for a uniaxial crystal it was stated $(n_1^2 - 1)^{-1} - (n_2^2 - 1)^{-1} = C$, where n_1 and n_2 are the ordinary and extraordinary indices, and C is a constant. The author recalculated C from Gifford's results from 1852 to 7950 Å.U., and Carvallo's from 8320 to 21,719. At both ends of the scale C decreases, but for the range 3961 to 8320 C is remarkably constant and has a mean value of 0·014416. Employing this relation and a dispersion formula for the ordinary index given by Coode-Adams, $n_2 - n_1$ may be calculated for any wave-length. These calculated values agree with experiment within the experimental limits of error. R. S. R.

3005. Simple Demonstration of the Michelson Interferometer. H. O. Kneser. *Phys. Zeits.* 30. *pp.* 251–252, *May* 1, 1929.

The author describes a lecture demonstration which can be used to show the fringes produced by a Michelson interferometer. For monochromatic light a mercury-arc lamp can be used, and with a path difference of about 200 wave-lengths the fringes are of almost undiminished sharpness. R. S. R.

3006. Photoelastic Apparatus. *Optical Soc., Trans.* 30. 3. *pp.* 135–136, 1928–1929.

Description of Coker's apparatus, made by Adam Hilger, Ltd., for determining the stress-distribution in parts of machines and structures, by observations made on models constructed of transparent materials. Polarised light is employed. A. D.

3007. Curvature of Images in Spherical and Paraboloidal Mirrors. D. P. Misra. *Tohoku. Math. J.* 30. *pp.* 478–505, *Feb.*, 1929. *In English.*

The author seeks to show the experimental fact that the image of a straight object in a paraboloidal mirror is curved. He deals first with spherical mirrors, assuming (1) that the object lies inside the cylinder formed by straight lines drawn through the periphery of the mirror parallel to the principal axis, and (2) that all rays originating from a single point will after reflection converge to a single point. The treatment in the paper is wholly mathematical, and the results obtained for the character of the image for spherical and paraboloidal mirrors under specified conditions regarding the size, shape and position of the object are tabulated. R. S. R.

3008. Measurement of Axial Aberrations of Telescopic Systems. B. E. Mourashkinsky and (Miss) M. Savostianoff. *Optical Soc., Trans.* 30. 2. *pp.* 49–67, 1928–1929.

The author sets out a system for measuring spherical and chromatic aberrations of telescope systems in which the form of the curve for the former is expressed in dioptric measure. The method employed and the results obtained for the axial aberrations of three binocular telescopes are given, one of these being set out with more detail to show the accuracy attainable. The curves of spherical aberration are shown for four filters —blue, green, yellow and red. The results obtained for diaphragms with (1) slits and (2) round apertures are also compared. A close agreement for mean values is obtained in a comparison of computed and experimental values, but some discrepancies occur for individual values. In the *Discussion*, **T. Smith** mentioned that the theory given is really that for an objective with axial aberration, and not for a telescope, and the central aberration in the telescope may be considerable; **P. E. Everitt** stated that in prismatic binoculars errors due to mechanical imperfections of the mounting may be fairly large. R. S. R.

3009. Application of the Interferometer to the Goniometry of Prisms. D. S. Perfect. *Optical Soc., Trans.* 30. 3. *pp.* 118–125; *Disc.,* 125, 1928–1929.

A method is described by means of which the goniometry of prisms may be effected with an accuracy of about 0·1 sec. The chief apparatus consists of a Hilger Interferometer No. 1, to which small additions are made, and a hollow prism, the deviation due to which may be varied by altering the pressure of the air within it. A manometer connected to the prism provides a linear scale of angles having calculable constants, and the directional coincidence of the fringe systems with a horizontal crosswire provides the criterion by which settings are made. AUTHOR.

3010. Double-Reflection Level. D. S. Perfect. *Optical Soc., Trans.* 30. 3. *pp.* 126–128; *Disc.,* 129, 1928–1929.

The level described in this paper was designed to assist the initial levelling of a floating system and to enable observations to be made on the constancy of level over extended periods of time. Its error may be determined by direct measurement and without reversal. The level in any direction is shown. The device has proved quite convenient in use, and may possibly be found suitable for other purposes. AUTHOR.

3011. Skew Pencils Traversing a Symmetrical Instrument. T. Smith. *Optical Soc., Trans.* 30. 3. *pp.* 130–132; *Disc.,* 132–133, 1928–1929.

Image points on a chief ray in a primary plane of a symmetrical instrument for which the light path is constant for a light fan lie between the primary and secondary foci. When the chief ray is skew this is no longer generally true. The absence of astigmatism in a pencil of which the chief ray is skew involves three conditions. AUTHOR.

3012. Photographs of Reflection Caustics. T. Smith, J. S. Anderson and L. C. Cordle. *Optical Soc., Trans.* 30. 3. *p.* 134, 1928–1929.

The photographs are of caustics obtained by light reflected successively at two surfaces of a photographic lens. AUTHORS.

3013. Adjustment and Use of the Brace Half-Shadow Compensator. G. Szivessy. *Zeits. f. Physik,* 54. 7–8. *pp.* 594–596, 1929.

A simplified and more accurate theory of the adjustment of the Brace half-shadow compensator than that contained in Kohlrausch's "Lehrbuch der praktischen Physik" is given. J. S. G. T.

3014. Form Determination of Microscopic and Ultramicroscopic Objects. E. Spenke. *Ann. d. Physik*, 1. 7. *pp.* 829–890, *April* 19, 1929.

In this paper the secondary conditions necessary for an extended use of the proposal to use measurements on diffraction rings for the estimation of the dimensions of objects are developed. This proposal was first suggested by Gans [see Abstract 277 (1926)], and the present author extends this, considering the results of later work. Part I deals with the influence of larger apertures than were considered by Gans, examining the case of finite objective apertures with infinitely small condenser apertures. It is shown that under certain conditions the diffraction ring has an elliptical shape, and is not circular, but the maximum deviation from the circular ring is small and can be neglected. In Part II the action of the condenser is considered, when the finite condenser aperture with the infinitely small objective aperture is dealt with. Part III deals with the mathematical foundations and the principal transitions of the method of measurement. Each general type of particle is fully considered, namely, the pair of points, the linear particle, the rectangular particle, including the special case when the length becomes very great compared with the breadth, the circular disc, and the spherical shell. Finally, a few experimental results for these types of particles are given, and a brief discussion of the conclusions they lead to. The paper is mainly mathematical.

R. C. F.

3015. Turbidity Measurements by the Pulfrich Step-Photometer. S. Gärtner. *Kolloid Zeits.* 48. *pp.* 10–15, *May*, 1929.

Experiments with solutions of various organic dye solutions (methylviolet, etc.) in glycogen, soap, or lysoform show that the Pulfrich stepphotometer, or photometric comparator [see Abstract 1626 (1925)] is suitable for turbidity determinations taken best in yellow-green light. The colour filter is conveniently placed behind the eyepiece, and not in the path of the rays before they enter the objective. The experiments should be made in cylindrical curvettes (5 to 50 mm. high) by preference to glass troughs. The method is only advisable when the extinction coefficients have been found to vary with the concentration of the solutions. H. B.

3016. Tan C . H/T Law of the Paramagnetic Rotation of the Plane of Polarisation. W. Schütz. *Zeits. f. Physik*, 54. 9–10. *pp.* 731–735, 1929.

The results obtained by Becquerel and de Haas [see Abstract 1508 (1929)] are discussed theoretically, and it is shown that, as required by these results, in the case of monatomic substances, paramagnetic rotation of the plane of polarisation at low temperatures is proportional to the magnetic field strength. J. S. G. T.

3017. Existence of Two Values for the Magnetic Rotatory Power Parallel with and Perpendicular to the Axis of a Uniaxial Crystal. J. Becquerel. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 523–535, 1929.

Tysonite, a mixed fluoride of the rare earths $[La, Ce, Na+Pr]F_3$, has the highest magnetic rotatory power, and the weakest double refraction of crystals containing the rare earths. Its *negative* magnetic rotation is of paramagnetic origin, since it increases as the temperature falls, and is almost inversely proportional to T until temperatures approaching those of liquid helium are reached, when it approaches a saturation value. A diamagnetic rotation is superposed on this, but is negligible at very low temperatures and weak even at room-temperature. The Verdet constant in the direction of the axis is given by $V_A = -6\cdot175 \times 10^{-3}$; that perpendicular of the axis is $0\cdot828$ times this value. T. M. L.

3018. Diamagnetic and Paramagnetic Rotation of the Plane of Polarisation in a Crystal. J. Becquerel. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 536–549, 1929.

The magnetic rotatory power of plates of tysonite $1\cdot866$ and $0\cdot675$ mm. in thickness was measured with fields of varying strengths at $4\cdot21°$, $1\cdot71$ and $1\cdot40°$ A, and for wave-lengths $4258\cdot9$, $5328\cdot5$, and $6249\cdot5$, with the help of a bath of liquid hydrogen. At these low temperatures the rotation is no longer proportionate to the field, but is expressed with the help of a hyperbolic tangent, as $y = A\mathit{tgh}CH$, where $C = 3\cdot923 \times 10^{-5}$ at $1\cdot7°$ Abs. This is Curie's law. Assuming that the rotation is proportional to the magnetisation-effect which produces it, CH is identified with Langevin's a, so that $c = \Sigma_\infty/R\Gamma$, where Σ_∞ is the saturation-magnetisation reduced to a gramme-molecule and expressed in magnetons. Taking two limiting values for the temperature of the cryostat (helium boiling under 9 mm. pressure) the value of Σ_∞ comes out on either side of unity; conversely if Σ_∞ is assumed to be exactly one Bohr magneton the temperature is $1\cdot714°$ Abs. If the values of the rotation ρ at $4\cdot21°$ are then plotted against H/T a curve is obtained in which the ordinates are in a constant ratio with those for $1\cdot7°$, so that the law of the hyperbolic tangent is valid at $4\cdot21°$ also. A similar curve was also obtained at a still lower temperature (pressure of $2\cdot8$ mm.), where the temperature calculated from the vapour-pressure was $1\cdot4°$ Abs., whilst the assumption that one Bohr magneton was involved gave the values $1\cdot41$ and $1\cdot39°$ Abs. [see also preceding Abstract]. T. M. L.

3019. Polarisation of Light in Hydrogen Canal Rays. I. Walerstein. *Phys. Rev.* 33. *pp.* 800–814, *May*, 1929.

Hydrogen canal rays were allowed to pass through a kathode so constructed that the light of the canal particles could be observed in the 6 mm. length of the canal, for a distance of 5 mm. below the canal, and for several cm. in the high vacuum chamber above the canal in which the intensity of the light falls off exponentially. The light of the canal rays in the canal and below it is partially polarised with the amount of polarisation depending on the material of the kathode. The ratio of the intensity of the light vibrating in the direction of motion of the particles to that perpendicular to the motion is $1\cdot20$ for brass, and only $1\cdot09$ for aluminium. Beyond the canal the polarisation falls rapidly and completely disappears in a distance of 6 mm. When electric fields are applied to the canal ray, the dying out of the polarisation is disturbed, and fluctuations of the degree of polarisation occur which are nearly periodic along the length of the beam. With fields perpendicular to the ray the number of these changes in the polarisation in a given length increases slightly with increase of field strength. The wave-length of one of these changes varies almost directly with the velocity of the rays. E. E. F. d'A.

3020. Polarisation Phenomena with Step-Up Excitation of the Fluorescence of Mercury Vapour. W. Hanle and E. F. Richter. *Zeits. f. Physik*, 54. 11–12. *pp.* 811–818, 1929.

The line 2537 excites Hg vapour to the 2^3P_1 state, and with the addition of nitrogen to the metastable 2^3P_0 state. From the last state the atom can only give up energy in the presence of another receptive substance. Excitation with line 4047 brings it to the 2^3S_1 state, whence it can emit the lines 4047, 4358 and 5461. This paper concerns investigation of the polarisation effects. These are described and explained, and the consequences of the explanations lead to suggestions for further work. J. E.

3021. Diffusion of Light. R. Holzapfel. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 190–203, 1929.

The author considers in the paper the changes that radiation undergoes as a result of diffusion in passing through a turbid medium with special reference to the loss of solar radiation in the atmosphere. A mathematical statement of the process of diffusion in a turbid medium is given to get the dependence of the incident radiation on the path and degree of turbidity. A series of laboratory experiments on cloudy media composed of a mixture of water, alcohol and peppermint oil gave qualitative results, but no reliable quantitative figures. Measurements of the intensity of solar radiation were made in 1927 on the Hochobir, Carinthia, using a Michelson-Marten actinometer, and the results for four typical days are tabulated and discussed. The results show that the changes in the passage of a stream of energy can be explained by alterations of the diffusion coefficient of the atmosphere in consequence of secondary action of solar radiation. This is confirmed by the results from fine days and those with small disturbances. R. S. R.

3022. Diffraction of Light by a Circular Opening and the Lommel Wave Theory. M. E. Hufford and H. T. Davis. *Phys. Rev.* 33. *pp.* 589–597, *April*, 1929.

The purpose of this paper is to check the energy in a diffraction pattern of 70 rings secured by passing monochromatic light through a circular orifice. The assumptions made are those of the classical wave theory of light, and the mathematical development follows that given in the celebrated papers of E. Lommel. The mathematical interest centres in the discovery of divergent series asymptotic to the Lommel functions $U_1(x)$ and $U_2(x)$. Photographs of diffraction patterns by circular openings 1·492 cm. and 1·832 cm. respectively in radius are shown. The smaller of these was used for a comparison of the radii of the diffraction rings calculated by the equations of Lommel's theory with radii measured from the pattern. Graphs of the functions, M^2, J_1, U_2, U_1 are shown. Values of these functions were calculated for 256 values of x, where x represents the root values of $J_1(x) = 0$ and $J_0(x) = 0$. The comparison of measured and calculated radii is shown in a table with the per cent. of difference. The agreement is also shown by a graph. The striking agreement of the calculated energy with that found in the diffraction pattern, particularly as shown in the broadening and darkening of the rings towards the outer part of the pattern, gives renewed confidence in the classical theory of light as applied to diffraction phenomena. AUTHORS.

3023. Theory of Photochemical Appearances. E. Haschek. *Akad. Wiss. Wien, Ber.* 138. 2*a*. 1–2. *pp.* 35–40, 1929.

Uses the photochemical theory previously developed for the action of colour-vision [see Abstract 1136 (1929)] to explain the fluorescence and phosphorescence phenomena. Experimental proof of the theory is obtained from results of the spectral sensitivity distribution for photographic plates. R. C. F.

3024. Influence of Pressure on the Photochemical Formation of Hydrogen Bromide. W. Jost and G. Jung. *Zeits. f. phys. Chem.* 3. *Abt. B.* 2. *pp.* 83–94, *May*, 1929.

Experiments are now described which show that, within the limits of experimental error, the influence of pressure upon the photochemical formation of hydrogen bromide as demanded by theoretical considerations is quantitatively confirmed. H. H. Ho.

3025. Functions of the Walls of the Containing Vessel in the Photochemical Action of Hydrogen and Chlorine. A. Trifonoff. *Zeits. f. phys. Chem.* 3. *Abt. B.* 3. *pp.* 195–203, *May*, 1929.

The author gives the results of his investigation as to how the velocity of photochemical formation of HCl depends on the dimensions of the cylindrical container. This investigation is analogous to that on the oxidation of phosphorus [see Abstract 1081 (1928)]. For low pressures (about 10 mm. Hg.) the yield is proportional to the square of the diameter of the vessel. With increase of pressure the dependence becomes weaker. It is possible to explain these facts on the theory of chain development as well as to draw conclusions as to the probability of the reactions: $H + Cl_2 = HCl + Cl$ and $Cl + H_2 = HCl + H$. J. K.

3026. Action of Compensated Developer. K. Wenske. *Phot. Indust.* 27. *pp.* 482–484, *May* 1, 1929.

From a microscopic examination of plates exposed through a neutral wedge, developed either by normal metol-hydrokinone developer, or by a compensated developer, such as metol free from alkali, and then fixed in thiosulphate solution, a comparison is obtained between the action of the two types of developers. It is shown that the metol-hydrokinone developer acts on a certain number of silver-bromide nuclei, and completely reduces them to dense black balls. The compensated developer, however, is more general, although not so drastic in its action, the particles reduced being smaller and more numerous, and the density varied considerably according to the light action. Reasons for the phenomena observed are discussed from considerations of "nucleus interior development" and "nucleus surface development." R. C. F.

3027. Photographic Printing with Diazo Compounds. J. M. Eder. *Phot. Indust.* 27. *pp.* 484–486, *May* 1, 1929.

Continues the previous paper on diazotypes [see Abstract 2162 (1929)] by giving results of the sensitometric examination of diazotype paper, their colour sensitivity and gradation. It is found that the diazotype papers are four to six times as sensitive to daylight as ferro-gallic paper, whilst the light from an enclosed flame arc is also very suitable for printing. The gradation values for all types of paper are approximately the same, and correspond to extra-hard gaslight paper. Diazotype papers possess a somewhat higher sensitivity to the violet and blue rays than do silver-chloride emulsion papers, but their sensitivity to green and red rays is much smaller, and they can be considered to be almost insensitive to these colours. R. C. F.

3028. Three-Colour Copying Processes. M. Mudrovčić. *Phot. Indust.* 27. *pp.* 582–584, *May* 29, 1929.

Describes the results of experiments carried out on certain German three-colour processes in which details of methods and chemicals are given whereby it is possible to obtain results almost as good as with the recom-

mended materials. These are extremely useful when situated in places where the obtaining of such materials is a costly and lengthy process.
R. C. F.

3029. Normal Light Source for Photographic Sensitometry. J. M. Ede. *Zeits. f. phys. Chem.* 141. *Abt. A.* 5–6. *pp.* 321–330, *May*, 1929. *Zeits. f. Wiss. Phot.* 26. *pp.* 353–362, *June*, 1929.

Recommends the use of the light from burning magnesium, after passing through the Davis-Gibson copper cobalt solution, for the sensitometry of photographic negative and positive materials. This transmitted light possesses the same spectral energy distribution as the average midday sunlight with a colour temperature of 5000° K, thus conforming to the internationally defined light standard for this sensitometry. The transmission factor of the solution and containing cell is 0·50 for the visible spectrum, being somewhat higher in the ultra-violet, which, however, can be compensated. The light from a carbon arc can also be used after passing through the copper cobalt filter, for sensitometric work. A table of relative intensities in the blue, green and red regions of the spectrum, considering the unfiltered light from burning magnesium as unity in each case, is given for various light sources. This table enables the change from one light source to another of different colour temperature to be easily made, and is especially useful for panchromatic plates and the three-colour processes. The filtered magnesium light is also very suitable as an illumination for copying papers, and examples of the sensitivities of silver-chloride papers, both normal and specially sensitised, as well as diazotype papers, are given. The diazotype papers possess the highest ultra-violet and violet sensitivity, whilst the silver-chloride papers sensitised by pinaflavol in the presence of sodium nitrite are extremely sensitive to yellow and green radiations.
R. C. F.

3030. Application of Talbot's Law to Photoelectric Cells with a Non-Linear Illumination Characteristic. G. H. Carruthers and T. H. Harrison. *Phil. Mag.* 7. *pp.* 792–811, *May*, 1929.

In view of the unsatisfactory nature of the evidence regarding the applicability of Talbot's law to photoelectric cells, particularly those with linear characteristics, specimens of as many types of cell as possible were tested. There were included K, Na, Li, Rb, and Cs cells, some being gas-filled and some evacuated. The results of the tests are tabulated. The results obtained by the thermionic-bridge method indicate that Talbot's law holds for photoelectric cells whether their response is proportional to the illumination or not. The failure of proportionality is ascribed to a rapid fatigue effect during the time that the cell is exposed to the illumination, and a recovery effect during the period that the cell is occulted by the sector. For a cell where the proportionality law holds there is no such rapid fatigue and recovery.
R. S. R.

3031. Optical Relationships between Alkali Halogen Phosphors and Complex Salt Solutions. H. Fromherz and W. Menschick. *Zeits. f. phys. Chem.* 3. *Abt. B.* 1. *pp.* 1–40, *April*, 1929.

Pohl [see Abstract 995 (1927)] and others have shown the intimate relation between phosphorescence and photoelectric effect in the case of alkali halogen phosphors. For these effects it is known that the presence of a small amount of impurity (*e.g.*, Ag in NaCl) is necessary, and that the absorption band in the ultra-violet is due to a complex. From this point of view the absorption bands observed by Smakula and MacMahon (alkali halide and silver halide and alkali halide and copper halide crystals) were compared with the corresponding bands of the concentrated solutions—pure and mixed. It is found that the absorption bands of all the solutions are slightly shifted toward the red, as compared with that of the crystal. From a comparison of the size of the absorption bands in the crystals and in the complex solutions it is concluded that not more than 2 % of the whole is optically active as regards the production of the absorption. J. E.

3032. Fluorescence in Flames and the Extinction of Fluorescence in Mixtures of Gases at High Pressure. R. M. Badger. *Zeits. f. Physik*, 55. 1. *pp.* 56–64, 1929.

The fluorescence of several metallic vapours, particularly of thallium vapour, when vaporised in a Bunsen flame, was investigated, and it was shown that such fluorescence is a somewhat general phenomenon, but is not at all marked in the case of the alkali metals, being only observed under the most favourable conditions in the case of sodium. In thallium the fluorescence was obtained by passing light from a thallium amalgam lamp through the flame, the air supplied to the latter being charged with a spray of thallium nitrate solution. The fluorescence is chiefly due to the 3776 Å. line from the exciting source. An attempt was made to obtain sensibilised fluorescence by introducing two different metals into the flame and exciting it with light due to one of them; in no case was any fluorescence of the second metal observed. Experiments were made on the extinction of mercury fluorescence in mixtures of N_2 and H_2 at high pressures and low temperatures. The action of the mixtures could be predicted qualitatively from those of the separate gases. H. N. A.

3033. Influence of Magnetic Fields on the Fluorescence of Mercury Vapour. H. Niewodniczański. *Zeits. f. Physik*, 55. 9–10. *pp.* 676–689, 1929.

An investigation of the effect of strong magnetic fields on the fluorescence of mercury vapour indicates that the effect of a magnetic field observed by Franck and Grotrian is not confirmed. On the other hand a mechanical effect of an inhomogeneous field appears to exist. Using a mercury arc, or the line λ2537 Å., it is found that the whole of the fluorescence in the tube is affected by a local application of the field to the point of excitation. The effect is attributed to a Zeeman effect, together with the fine structure of the 2537 Å. line. It is concluded that the mercury atom and not the molecule is excited by the line 2537 Å. The visible fluorescence remains unpolarised by the application of the magnetic field. J. E.

3034. Luminosity of the Atom. D. G. Bourgin and E. E. Libman. *Ann. d. Physik*, 1. 8. *pp.* 1096–1098, *May* 7, 1929.

Give reasons for believing that the paper by J. Kleiber [see Abstract 803 (1929)] does not succeed in putting the atom on a classical basis. The transitions between the various Bohr orbits cannot be neglected. If a slight oscillation about a stationary orbit be assumed, a simple calculation shows that its frequency cannot be that assumed by Kleiber. E. E. F. d'A.

3035. Hg-Atom: Optical Measurements. M. Schein. *Helv. Phys. Acta*, 2. [111 *pp.*], 1929. *In German.*

Too long and condensed a paper for abstracting within a reasonable compass. Introduction; general considerations; Döppler breadth of a spectral line; resonance radiation of mercury vapour. Part I: Hyperfine structure and Zeeman effect in mercury resonance lines. Part II: Stark effect in mercury resonance radiation. Part III: Döppler effect and thermal velocity of the mercury atom. A. D.

3036. Ultra-Violet Radiation in Tropical Sunlight. J. C. Boerema and M. P. Vrij. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 435–439, 1929.

Preliminary observations made with a small quartz spectrograph have recorded radiations as far as 2954 Å. at the most unfavourable time of year. Comparison with other available data shows that shorter radiations have only been recorded at Marseilles under most favourable conditions. Little extension was found to result from an increase in altitude of 1400 m. F. S.

3037. Raman Effect in Acetone. J. W. Williams and A. Hollaender. *Nat. Acad. Sci., Proc.* 15. *pp.* 421–423, *May*, 1929.

By photographing the Raman lines of acetone thirteen infra-red frequences have been deduced. J. E.

3038. Raman Effect in Liquids. A. Petrikaln and J. Hochberg. *Zeits. f. phys. Chem.* 3. *Abt. B.* 3. *pp.* 217–228, *May*, 1929.

Eleven organic liquids were examined, using Wood's arrangement [see Abstract 513 (1929)] and a glass prism spectrograph. Tables of results are given, and the results are discussed in relation to the significance of Raman spectra for the stability of organic compounds. F. S.

3039. Raman Effect in Gases. R. W. Wood. *Phil. Mag.* 7. *pp.* 744–749, *April*, 1929.

Spectrograms have been obtained of light of modified wave-length scattered from gases using exciting light from Hg-vapour lamp. With HCl a single line is obtained for each exciting line, and differing from it by the missing line of the infra absorption at 3464 μ. Diagrams of the apparatus and much experimental detail is given. Ammonia also gave single lines for each exciting line corresponding to the infra-red absorption band at 3 μ. No trace of the lines corresponding to strong absorption bands at $6 \cdot 5$ μ and 10 μ has yet been obtained. J. E.

3040. Raman Effect in Gases. E. L. Hill and E. C. Kemble. *Nat. Acad. Sci., Proc.* 15. *pp.* 387–392, *May*, 1929.

This is a theoretical analysis on the basis of wave mechanics of the Raman effect to be expected in the case of diatomic molecules. The work of Wood on HCl and of McLennan and McLeod on liquid H_2 has shown that the results can be interpreted on the assumption of new selection rules for the rotational quantum number j. These are discussed, and the relative intensities and states of polarisation of Raman lines are considered. F. S.

3041. Raman Effect by Helium Excitation. R. W. Wood. *Phil. Mag.* 7. *pp.* 858–866, *May*, 1929.

The author's previous method [see Abstract 513 (1929)] of irradiating fluids by the light of the mercury arc for the excitation of the Raman lines of modified wave-length has been still further improved, and the present description is given for the benefit of workers who lack facilities for excitation by helium. At best, however, the mercury arc is a very unsatisfactory source, owing to the impossibility of isolating a strictly monochromatic radiation from it, and work is now described with the helium vacuum tube, spectra being obtained of the lower alcohols, and a number of benzene substitution compounds, including the three isomers of xylene and methyl cyclo-hexane. H. H. Ho.

3042. New Regularities in the Band Spectrum of Helium. Part II. G. H. Dieke, S. Imanishi and T. Takamine. *Zeits. f. Physik*, 54. 11–12. *pp.* 826–843, 1929.

Gives a number of new helium bands; in most cases they are higher series members or vibration bands of the bands previously found. Explains the meaning attached to the signs P, Q and R for the branches in this part, which differs from that used in Part I [see Abstract 3016 (1928)], but agrees with that employed by most other authors. Points out difficulties which arise with the present convention, and in some cases uses the symbols $\overline{P}$, $\overline{Q}$ and $\overline{R}$, with the meanings attached in Part I. Introduces the idea of term complexes. The band complex $2p - 3\delta$, for example, is formed of the bands $2p - 3d$, $2p - 3x$, $2p - 3y$, and $2p - 3z$. Gives tables containing the values of λ, I and ν for the P, Q and R branches of the bands of the $2p - 4\delta$ complex, and for certain other bands and complexes. Other tables give the combination differences for the different lines, in several cases these enable the final state to be determined. H. N. A.

3043. Arc and Spark Spectra of Yttrium. W. F. Meggers and H. N. Russell. *Bureau of Standards, J. of Research*, 2. *pp.* 733–769, *April*, 1929.

All the available data, including Zeeman effect, have been correlated and analysed. The lines classified are 448 for YtI, 223 for YtII, and 10 for YtIII. Series-forming terms have been identified in each spectrum, and ionisation potentials of 6·5, 12·3 and 20·6 volts respectively deduced. Comparison is made with the corresponding spectra of scandium, and the results are shown to be in accordance with Hund's theory. F. S.

3044. Arc Spectrum of Samarium. S. P. de Rubies. *Comptes Rendus*, 188. *pp.* 1101–1102, *April* 22, 1929.

The measurements made previously have been extended to cover 157 lines in the range from 2750 to 2200 Å.U. T. M. L.

3045. Arc Spectrum of Germanium. K. R. Rao. *Roy. Soc., Proc.* 124. *pp.* 465–477, *June* 4, 1929.

Observations of the arc spectrum have been extended to 1630 Å., using a quartz and a vacuum grating spectrograph, and about fifty new lines have been found. Gartlein's analysis [see Abstract 2397 (1928)] has been slightly modified to bring it into better agreement with the spectra of some related elements. The absolute values of some of the terms have been calculated, and an ionisation potential for GeI of 8·09 volts is deduced. F. S.

3046. Spark Spectra of Antimony. R. Soulillou. *Comptes Rendus*, 188. *pp.* 1103–1104, *April* 22, 1929.

Purified antimony was introduced into a silica tube without electrodes, and the spectrum from 3800 Å. to 1900 Å. studied. By varying the pressure and the conditions of discharge, three groups corresponding to SbII, SbIII and SbIV were identified, and are tabulated. F. S.

3047. Spark Spectrum of Nickel (Ni II). R. J. Lang. *Phys. Rev.* 33. *pp.* 547–548, *April*, 1929

Twenty-six lines resulting from intercombinations between the lowest terms $d^9\,{}^2D_{2,3}$ and eleven more terms of the d^8p configuration b^4S', b^4P, b^4D'; c^2S', c^2P, c^2D'; b^2P, b^2D', b^2F; c^2F; b^2G'; have been classified. These lines lie between 1537 and 1250 Å. [See also Abstract 2396 (1928).]

AUTHOR.

3048. Absorption Spectrum of Fluorspar. S. van der Lingen. *Zeits. f. Physik*, 53. 7–8, *pp.* 581–586, 1929.

The infra-red spectra of several specimens of fluorspar from England and from S.W. Africa were examined with a Hilger spectrometer. Marked differences were noted between the English and African specimens, the English showing a band probably due to a carbonate (? calcite or cerussite). Preliminary experiments by heating *in vacuo* to determine whether the varied colours were caused by presence of any gases indicated the presence of carbon monoxide, and a trace of water, but absence of any hydrocarbon. Spectroscopic examination showed absence of any rare earth, but presence of a trace of lead. The absorption spectra is visible and ultra-violet light also showed marked differences between the various specimens. C. A. S.

3049. Near Infra-Red Absorption Spectra of some Aldehydes, Ketones, Esters and Ethers. J. W. Ellis. *Am. Chem. Soc., J.* 51. *pp.* 1384–1394, *May*, 1929.

The infra-red absorption spectra below 2·5 μ have been recorded for a group of aldehydes, ketones, esters and ethers with the primary purpose of ascertaining where there are any features in such spectra assignable to the carbonyl group. The spectra of ethyl sulphate, pentane and three ethers have also been recorded for comparison purposes. An absorption band, often double, between 1·9 and 2 μ is interpreted as a second overtone of a prominent 5·8 μ band previously recorded by many observers. Both are assigned to the carbonyl group. Evidence pointing towards the existence of third, fourth and fifth overtones of the 5·8 μ band is found near 1·45, 1·16 and 0·97 μ in the spectra of some of the compounds. Features characterising hydrocarbons and their derivatives are found in these spectra at positions where they were anticipated. H. H. Ho.

3050. Absorption Spectrum of Liquid Benzene. J. W. Ellis. *Phys. Rev.* 33. *pp.* 625–626, *April*, 1929.

Is is shown that the assumption by Barnes and Fulweiler [see Abstract 507 (1929)] of a constant amplitude of vibration for all stationary states of an anharmonic oscillator is theoretically unsound. It is also pointed out that the precision of these authors' measurements on four bands in the visible and near infra-red absorption spectra of liquid benzene cannot be used as a test for the superiority of the new wave mechanics over the classical quantum theory. [See following Abstract.] AUTHOR.

3051. Absorption Spectrum of Liquid Benzene. J. Barnes. *Phys. Rev.* 33. *p.* 627, *April*, 1929.

The author replies to the criticism by Ellis [see preceding Abstract] referring to his earlier paper in collaboration with Fulweiler [see *Am. Chem. Soc. J.*, 49, p. 2034 (1927)].

3052. Absorption Spectra of the Rubrenes. A. Willemart. *Comptes Rendus*, 188. *pp.* 988–990, *April* 8, 1929.

The absorption spectrum of rubrene is of great interest not only because of the rôle of light in the reversible oxidation of this body, but also for the problem now considered of the mechanism of the formation of the rubrenes in relation to their constitution. The three known members of the class, *viz.*, rubrene, dimethylrubrene and dibenzorubrene, have similar absorption spectra, the bands not only being the same in number, but having their maxima at the same wave-lengths, 4650 Å., 4950 Å., and 5300 Å., the only differences being in intensities of absorption power. It is deduced that the three chromophoric groups are analogous and only differ by the number of benzene nuclei present, and that in consequence the naphthalene residues in dibenzorubrene play no part in the chromophoric activity. The method outlined in the paper enables the detection of rubrenes in a complex mixture which is difficult of resolution. H. H. Ho.

3053. Ultra-Violet Spectroscopy of the Flames of Motor Fuels. Part IV. Practical Utilisation of Small Quartz-Prism Spectrograph for the Quantitative Determination of Lead Tetraethyl in Gasoline. G. L. Clark and H. A. Smith. *J. Phys. Chem.* 33. *pp.* 659–675, *May*, 1929.

In the preceding papers of this series the method of spectroscopy has been successfully applied to the analysis of the flames of motor fuels. In the present investigation it is demonstrated that a small quartz prism spectrograph is simple, accurate and flexible in such problems as the estimation of lead tetraethyl in gasoline and of its effect upon a detonation flame. Further evidence is obtained that the detonation supressor action of lead tetraethyl is due to the process of its decomposition and to the products of disintegration. In addition to the exploration of the flame spectrum of lead, where an additional emission line has been discovered for the first time (λ2167), the band positions, structures, and intensities have been compared for flames of various fuels such as gasoline, gasoline plus ethylene, bromide gasoline plus lead tetraethyl, benzene, alcohol and ether. T. B.

3054. Perturbations in Band Spectra. Jenny E. Rosenthal and F. A. Jenkins. *Nat. Acad. Sci., Proc.* 15. *pp.* 381–387, *May*, 1929.

In the case of some violet CN bands previously considered [see Abstract 1922 (1928)] large perturbations were noticed. These are demonstrated by fitting a formula connecting ν and j, this quantum number referring to states in which the spin annular momentum is parallel to that of the nuclei. When plotted, the formula yields a curve exhibiting the perturbations by branches similar to anomalous dispersion curves. The principal results of Kronig's discussion of the origin of perturbations [see Abstract 3234 (1928)] are verified. It is proposed to treat similarly the bands of SiN, CO, N_2^+, BeO and HgH^{--}. Perturbations are to be expected from Kronig's theory in the case of NO, but have not been found. F. S.

3055. Spectra of ZnII, CdII, InII and SnII. R. J. Lang. *Nat. Acad. Sci., Proc.* 15. *pp.* 414–418, *May*, 1929.

An analysis of these spectra bringing out some new classifications. J. E.

3056. Intensity Relations in the Spectra of Titanium. Part II. Relative Intensities of the Stronger Multiplets of TiI. G. R. Harrison and H. Engwicht. *J.O.S.A. and R.S.I.* 18. *pp.* 287–301, *April*, 1929.

The relative intensities of 16 of the more important multiplets of normal titanium have been measured in the vacuum arc. The intensities of the multiplets in triads are found to agree with Kronig's intensity formulæ. The agreement is closest if the effective temperature of the arc is taken as 10,000° Abs. when the average deviation is about 7 %. This is shown to be as good as could be expected, considering the wide separations involved, and the uncertainty of the ν^4 and excitation corrections, together with the fact that some of the multiplets contain lines which are abnormal in intensity. A triad due to a two-electron transition is shown to agree with Kronig's formulæ for the most closely analogous one-electron transition. Certain definite deviations from the intensity formulæ which cannot be due to experimental error are noted. The strongest line in the spectrum under normal excitation conditions is found to be λ3653·49, confirming the selection of this as the raie ultime by spectrochemical means. A number of quintet system lines were found to be stronger fundamentally than this, however, the greater inner quantum numbers overcoming the disadvantage of elevation of the metastable state. Curves showing the relative amounts of self-reversal in multiplets coming from different lower states in the atom are given [for Part I see Abstract 1210 (1929)].

AUTHORS.

3057 Quantum Analysis of the Blue-Green Bands of Titanium Oxide. A. Christy. *Phys. Rev.* 33. *pp.* 701–729, *May*, 1929.

The plates measured in this investigation were taken on a 15-ft. grating using the electric furnace, iron and carbon arcs as sources. A table of frequencies of the heads is given and the quantum equation connecting them. The frequency of vibration for infinitesimal amplitude is 833·31 and 1003·60 cm.$^{-1}$ for the initial and final states. A heat of dissociation of 6·88 volts is calculated. The vibrational analysis suggests that the molecule in question is titanium monoxide. Tables of frequencies of the lines and samples of their combination differences are given for the (0, 0), (0, 1) and (1, 0) bands. No perturbations have been observed. Each band has three R and three P branches. Quantum numbers have been assigned and empirical formulæ calculated for all branches of the three bands investigated. The moments of inertia are $56 \cdot 72 \times 10^{-40}$ and $51 \cdot 89 \times 10^{-40}$ g.cm.^{2}, and the nuclear separations $1 \cdot 693 \times 10^{-8}$ cm. and $1 \cdot 619 \times 10^{-8}$ cm. for the initial and final states respectively. The total quantum number j is found to be a half integer and there is triplet separation of the lines, indicating that the emitter is neutral TiO.

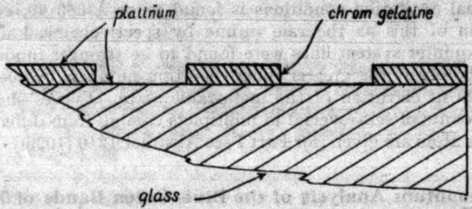
F. S.

3058. Molecular Spectrum of Ammonia. Part II. Double Band at 10μ. E. F. Barker. *Phys. Rev.* 33. *pp.* 684–691, *May*, 1929.

Grating resolution of the NH_3 absorption band, extending from 8 μ to 14 μ, shows two very narrow zero branches nearly equal in intensity, at 10·3 μ and 10·7 μ respectively, with each of which is associated a positive and a negative branch consisting of ten or twelve lines spaced at nearly equal frequency intervals (18·7 and 20·2 cm.$^{-1}$). Both bands must be associated with a single fundamental vibration parallel to the symmetry axis. Assuming as atomic configuration an axially symmetrical triangular pyramid with the nitrogen atom at the vertex, computation of line intensities from known transition probabilities for the ammonia band at 1·9 μ (previously reported), indicates that the nitrogen atom must lie between $0 \cdot 1 . 10^{-8}$ and $0 \cdot 3 . 10^{-8}$ cm. from the plane of the hydrogen atoms, which is approximately one-fifth the distance apart of the H atoms. The double character of the 10 μ band is shown to be a consequence of the close proximity of the two equilibrium positions for the N atom, one on either side of the plane formed by the H atoms (the possibility that the nuclear spins of the H atoms may not all be oriented in the same direction permits of the two sides of the H-atom plane being distinguished). W. S. S.

3059. Pure Rotation Spectrum of Ammonia. R. M. Badger and C. H. Cartwright. *Phys. Rev.* 33. *pp.* 692–700, *May*, 1929.

New experimental methods for absorption spectrum measurements in the extreme infra-red (30 μ–150 μ) are described. A type of "luminary" reflection grating was employed (see Figure). Ammonia gives in the wave-length range, 55 μ–150 μ, a simple series of lines separated by approximately equal frequency intervals ($v = 19 \cdot 957\ m. - 0 \cdot 0050826\ m.^3$ wave numbers). These are ascribed to changes in the energy of rotation about an axis normal to the line of symmetry, *i.e.*, to transitions in which the quantum number j increases by unity, lines due to changes in rotation energy about the symmetry axis not being observed. The results are shown to be in agreement with wave-mechanics predictions (Hund). The moment of inertia of the ammonia molecule about an axis normal to the line of symmetry is estimated at $2 \cdot 77 . 10^{-40}$ gm.-cm.². W. S. S.



3060. Broadening of Spectral Lines. J. Holtsmark. *Zeits. f. Physik*, 54. 11–12. *pp.* 761–763, 1929.

The quantum-mechanical explanation of the coupling theory of the broadening of lines is discussed on the assumption of the proportionality of width to the square root of the density of resonators. When only two resonators are in question the width is found to be proportional to the density. Waibel's application of the coupling theory [see Abstract 2181 (1929)] is corrected to bring about agreement of his results and the author's. F. S.

3061. Intensity of Spectral Lines. W. Hanle. *Zeits. f. Physik*, 54. 11–12. *pp.* 852–855, 1929.

In the apparatus used the light given off from mercury vapour bombarded by electrons could be observed in a direction perpendicular to the direction of the beam of electrons and in the direction of the beam. The intensities of the two Hg lines 3663 (2^3P_2–3^1D_2) and 3132 (2^3P_1–3^1D_2) could be measured. Observing in the direction parallel to the electron beam 3663 compared with 3132 was 10 % stronger than in observations perpendicular to the beam. This shows qualitatively that the intensity relation between two multiplet lines proceeding from the same term is not constant. Using Skinner's values for the polarisation of the emitted light it appears that if A is the ratio of the intensities of 3132 and 3663 observed in the direction of the beam, and B the ratio for the perpendicular direction, A/B = 0·5 in the most favourable case, with absolutely parallel electrons, very low pressure and absence of external fields. Practically instead of 50 % the difference between the intensity ratios is only of the order of 10 %. H. N. A.

3062. Intensity Variations in Pressure-Widened Spectral Lines. R. Minkowski. *Zeits f. Physik,* 55. 1. *pp.* 11–27, 1929.

Examines the effect of various gases at low pressures on the intensity at various points in the pressure-widened D lines of sodium. The gases used were helium, neon, hydrogen, argon, nitrogen, methane, ethane and propane, and it is shown that for low pressures of these gases the measured intensity curves of the D lines agree with those calculated by means of the collision-suppression theory. As the pressure of the foreign gases is increased, deviations in the shapes of the intensity curves occur, the deviations being greater on the low wave-length side for gases of low molecular weights and on the high wave-length side for gases with high molecular weights. It is concluded that the deviations found are due to the combined effect of radiation and collision. R. C. F.

3063. Infra-Red Spectrum of Some Halogen Compounds. G. B. Bonino. *Zeits. f. Physik,* 54. 11–12. *pp.* 803–805, 1929.

It is found that the bad agreement between the Raman lines and the infra-red bands stated by Pringsheim and Rosen to occur in the case of some halogen compounds studied by the author actually does not exist. If the comparison between λ_{Ra} and $\lambda_{inf.r}$ is strictly made, full agreement for $C_2H_2Cl_4$ and a better agreement for $C_2H_2Cl_2$ are shown. J. J. S.

3064. Zeeman Effect in the Spectrum of Ionised Neon (NeII). C. J. Bakker. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 515–522, 1929.

In connection with previous work on ArII [see Abstract 489 (1929)], it became important to make similar measurements for a lighter rare gas. The same apparatus was used as before, photographs being taken with a 6-inch grating in stigmatic mounting and field strengths up to 41,000 gauss being used. The *g*-values of terms arising from 3*s* and 3*p* electrons are tested by Landé's *g*-formula. Some anomalous *g*-values are found and compared with *g*-values of the analogous terms of ArII. F. S.

3065 Polarisation of Light due to Collisions between Electrons and Neon, and to Neon Canal Rays. W. Hanle and B. Quarder. *Zeits. f. Physik,* 54. 11–12. *pp.* 819–825, 1929.

The polarisation of the light produced by a beam of electrons in neon at low pressure was investigated. Most of the lines show partial polarisation; in some cases parallel, and in others perpendicular to the direction of the beam. The degree of polarisation diminishes with increased velocity of the electrons; the optimum lies at about 20 to 25 volts, accelerating voltage. The results are compared with the values found for mercury, and essential agreement is found for analogous lines. Using the same tube with a different arrangement of the electric circuit, slow neon-canal rays were produced, and the polarisation of the light given off by them was investigated; the light was very weak and several days were necessary to obtain satisfactory photographs. Partial polarisation was observed. It was found that a weak magnetic field alters the relation between the intensity of the mercury triplet lines and the other mercury and the neon lines. H. N. A.

3066. γ-Bands of Nitric Oxide. B. Pogány and R. Schmid. *Zeits. f. Physik,* 54. 11–12. *pp.* 779–787, 1929.

The bands were photographed with a large quartz spectrograph. Three light sources were used—a quartz tube filled with air at 30–40 mm. pressure and excited by direct current at 2000 volts, a copper arc, and the afterglow of nitrogen in a tube excited by a 50-kW transformer. The photographs were measured with a Zeiss microphotometer. The so-called effective temperature of emission is calculated, using the formulæ of Hill and van Vleck. F. S.

3067. Alteration of Resonance Lines by Frequently Repeated Compton Effects. W. Orthmann. *Zeits. f. Physik*, **54.** 11–12. *pp.* 767–778, 1929.

A recent paper by Orthmann and Pringsheim has showed qualitatively under what circumstances the explanation given by Franck of a certain astrophysical phenomena can be regarded as correct [see Abstract 1866 (1929)]. The author now considers a star of the type contemplated, at first simplifying the conditions by supposing uniform density for the exterior spherical mass of low-density gas, and a sharp boundary. The problem is treated quantitatively as one of the diffusion of light quanta, with diffusion constants which vary with the time. An estimate is made of the alteration which must result when the simplifying assumptions are dropped. H. N. A.

3068. First Spark Spectrum of Mercury, Hg II. F. Paschen. *Preuss. Akad. Wiss. Berlin, Ber.* 32. *pp.* 536–546, 1928.

The apparatus used is fully described, and a method of obtaining the desired spectrum with helium present in the tube given. A detailed table of the lines (some 300) observed is added, with a term-table and energy-level diagram. Previous results are discussed; those of Carroll [see Abstract 1354 (1926)] being to a considerable extent confirmed. C. A. S.

3069. Excitation Function of the Mercury Resonance Line 2537. W. Hanle. *Zeits. f. Physik*, 54. 11–12. *pp.* 848–851, 1929.

Describes the apparatus employed for exciting the mercury atoms by bombardment with a beam of electrons from a hot kathode. The light was measured by means of a photo cell containing a zinc plate; this had the advantage of not responding to visible light, so that the observation room did not need to be darkened. The relations between the photo current measured with a quadrant electrometer, and the current due to the electrons which passed through the mercury vapour and were caught by a plate as measured by a galvanometer, gave the relative output of light, the optical excitation function. The output grows at first linearly, and reaches a rather sharp maximum at about 1·5 volts, after which it falls off. The question of the effect of absorption of the light by the Hg vapour was investigated, and a further investigation of this effect is in progress. H. N. A.

3070. Structure and Significance of the Rare Gas Bands of Mercury. O. Oldenberg. *Zeits. f. Physik*, 55. 1. *pp.* 1–15, 1929.

An experimental investigation is given of the fine structure of the bands obtained on either side of the resonance line (2537), when the rare gases argon or krypton are mixed with the fluorescing mercury vapour. As previously indicated [see Abstract 1284 (1928)], these bands are attributed to molecule formation between the mercury vapour and the rare gas, and the reasons for this conclusion are developed at length. The bands are regarded as nuclear oscillation bands of the molecules HgAr and HgKr respectively, and if such is the case it follows that the rare gases possess in the normal state the power to form compounds. The optically determined polarisation of the rare gases is shown to be consistent with the formation of such compounds. W. S. S.

3071. Determination of the Concentration of Atoms and Ions by an Optical Method. W. de Groot. *Zeits. f. Physik*, 55. 1. *pp.* 52–55, 1929.

Discusses the influence of the broadening of an emission line by self-absorption on the optical measurement of concentration, and shows in a practical case that it can be considerable. Proves that the curve showing the relation between log J/J_0 and the concentration never has a point of inflection as the result of complications of this kind. H. N. A.

3072. Band Systems in the Molecular Spectrum of Hydrogen. Part II. W. Finkelnburg and R. Mecke. *Zeits. f. Physik*, 54. 9–10. *pp.* 597–631, 1929.

In this part of the paper 825 additional lines have been arranged by means of combinational relations and with certainty in 60 bands with 179 branches. A detailed discussion of all the facts shows clearly that these bands form the triplet system of the hydrogen molecule. Definition of terms, nuclear vibration numbers and moments of inertia are given for the terms 2^3S, 3^3P, 4^3P and 3^3D. All of the bands in question have the 2^3S term as common end term, and this is at the same time the initial term of the untra-violet Lyman bands. Including the Balmer singulet band system (α, β, γ and δ bands of Part I), the greater number, about 80 %, of the intense lines of the spectrum have now been classified, and it can be considered as proved that if H_2^+ and H_3 take any part in the production of the many-line spectrum, it is only a subordinate one. Altogether about one-third of the total number of lines are now classified. H. N. A.

3073. Continuous Spectrum of the Hydrogen Atom. P. S. Epstein and M. Muskat. *Nat. Acad. Sci., Proc.* 15. *pp.* 405–411, *May*, 1929.

The expressions given by Oppenheimer for hydrogen-like atoms are complicated and difficult to use numerically; the authors have obtained formulæ for transitions from continuous (hyperbolic) stationary states to discrete (elliptic) ones, which are convenient for numerical computations. They are arrived at by means of the representation of wave functions given in a previous paper by one of the authors, which is valid for the continuous or hyperbolic range; and the present paper deals with the properties of wave functions in the continuous range, the evaluation of the integrals, the normalising of the functions, and some examples of the application of the final formulæ. Curves calculated for the continuous absorption spectrum, beyond the limits of the Lyman and the Balmer series, are given. H. N. A.

3074. Spectrum of H_2: Bands Analogous to the Parhelium Line Spectrum. Parts III and IV. O. W. Richardson and P. M. Davidson. *Roy. Soc., Proc.* 124. *pp.* 50–88, *May* 2, 1929.

Continuing previous work [see Abstract 2741 (1929)], the new systems described are (1) $^1K \rightarrow 2^1S$, a strong system, $\nu_e = 21427$; (2) $^1L \rightarrow 2^1S$, similar to but weaker than the preceding system, $\nu_e = 23057$; (3) $^1M \rightarrow 2^1S$, intermediate strength, $\nu_e = 23191$; (4) $^1N \rightarrow 2^1S$, strong system but containing only two progressions, $n' = 0$ and 1; (5) $^1O \rightarrow 2^1S$, similar to

$^1A \rightarrow 2^1S$, but weaker and with $\epsilon = 0$, branches P and R, $\nu_e = 22814$; (6) $^1Q \rightarrow 2^1S$, similar to (5), $\nu_e = 21843$. In addition to these, single branch progressions commencing from $\lambda = 4142 \cdot 801$ and $\lambda = 4097 \cdot 433$ are described, and a general analysis is given of that part of the infra-red system for which measurements are available. W. S. S.

3075. Third Positive Carbon and Associated Bands. R. K. Asundi. *Roy. Soc., Proc.* 124. *pp.* 277–296, *June* 4, 1929.

The third positive carbon bands, the 3A bands, the Wolter bands (which are regarded as forming a new system) and a new band system have been photographed and their vibrational analysis given. These four band systems appear to have the same final electronic state. The fourth system, the new band system, has an initial leval at 0 = 58927, which is identical with the new level discovered by Hopfield and Berge for the CO molecule. A fine structure analysis of the 0 — 0 and 0 — 1 bands of the third positive system is given which indicates that the final level for these bands is a quintet P level, the transition being $^5S \rightarrow {}^5P$. It is suggested that the 3A bands are due to the transition $^5P \rightarrow {}^5P$. F. J. W.

3076. Infra-Red Investigations of Molecular Structure. Part I. C. P. Snow and A. M. Taylor. Part II. C. P. Snow, F. I. G. Rawlins and E. K. Rideal. *Roy. Soc., Proc.* 124. *pp.* 442–464, *June* 4, 1929.

Part I.—Details of apparatus and technique are given with particular reference to the use of a grating. The particular region of the infra-red required was first sorted out by means of a rock-salt prism before being passed on to the grating for the final resolution. The smallest separation resoluble by the spectrometer in the form described is estimated at one wave number.

Part II.—The absorption of the nitric oxide molecule (NO) was measured and its vibration-rotation band spectrum shown to be a fundamental, with its centre at $1882 \cdot 9$ cm.$^{-1}$, $n'' = \frac{1}{2} \rightarrow n' = \frac{3}{2}$; P, Q and R branches in the fine structure. There was no sign of the overtone band ($n'' = \frac{1}{2} \rightarrow n' = \frac{5}{2}$) which might be expected near $2 \cdot 7\ \mu$. The molecular constants derived from the separation of the fine-structure bands ($3 \cdot 35$ cm.$^{-1}$) correspond almost exactly with those obtained from electronic band spectra data. W. S. S.

3077. Refractive Indices and Anomalous Dispersion of Soft X-Rays in Platinum, Silver, Calcite and Glass. E. Dershem. *Phys. Rev.* 33. *pp.* 659–671, *May*, 1929.

General X-radiation passed through a vacuum spectrograph employing a gypsum crystal gave nearly homogeneous X-rays which were allowed to impinge on a mirror of the substance under test. The critical angle for total reflection was determined, and from this the refractive index for wave-lengths ranging from $0 \cdot 80$ to $9 \cdot 15$ Å. Curves are given relating $\delta = 1 - \mu$ with the wave-length, and the effects of anomalous dispersion are shown in lowered values of δ on both sides of an absorption limit wave-length of an element contained in the test substance. For silver the depressions in the δ curve occurred at the L_I absorption limit and another at the mean of the L_{II} and L_{III} wave-lengths, these not being resolved. Glass gave δ-curve depressions corresponding to the K limits of silicon and aluminium. Fair agreement with a Drude-Lorentz dispersion curve was obtained for regions not too close to an absorption limit. Surface conditions and thickness of film affected the absolute δ values considerably, leaving, however, the general shape of the curve unchanged. W. S. S.

3078. Optical Investigations in the X-Ray Region. F. Jentzsch. *Phys. Zeits.* 30. *pp.* 268–273, *May* 1, 1929. *Paper read before the Deut. Phys. Gesell., Leipzig, Jan.*, 1929.

Since X-rays possess a refractive index ($\mu = 1 - \delta$) different from unity, the possibility of the formation of optical images for X-rays is of great interest, but the smallness of δ makes the difficulty of their formation very great. For reflection the conditions are more easily obtained, though the angles of total reflection are small, being mostly below 30′. The theory of reflection of X-rays at spherical surfaces is first developed and it is shown that it is impossible to form an image for X-rays in this way. A doubly curved surface may be used, however, but only in special cases. The paper concludes with a discussion of the variation of the angles of reflection for various materials and wave-lengths and the effects of surface irregularities on the reflecting materials. W. V. M.

RADIOACTIVITY.

3079. Existence of Radioactive Recoil Ions of High Mobility. L. L. Loeb and L. B. Loeb. *Nat. Acad. Sci., Proc.* 15. *pp.* 305–310, *April*, 1929.

Using the Rutherford a.c. method for measuring the mobilities of the recoil ions (ThC′) from ThC, the authors have failed to confirm the existence of the ions of high mobility (4·35 cm./sec./volt/cm.) reported by Erikson [see Abstract 1186 (1925)]. Only the normal recoil ion of mobility 1·5 cm./sec./volt/cm. has been found, working over a time-interval range of 0·0006–0·03 sec. The result may be due to a fundamental difference between the recoil ions of the radium-actinium and thorium series, though possibly to the effect of radioactive contamination in Erikson's experiments. L. V. C.

3080. Energy Relations in Artificial Disintegration. E. Rutherford and J. Chadwick. *Cambridge Phil. Soc., Proc.* 25. *pp.* 186–192, *April*, 1929.

Discussing the measurements by Blackett [see Abstract 1680 (1925)] of the velocities of the residual nitrogen nucleus and the proton in the artificial disintegration of nitrogen, the authors obtain some further evidence of the magnitude of the energy change from the measurements of the maximum ranges of the protons liberated by bombardment of α-particles of different ranges. A small thin aluminium foil was bombarded by the α-particles of radium C′ of 7 cm. range. The liberated protons were observed in a direction at right angles to the direction of the α-particles, and their ranges were examined by the absorption method. To make sure that only protons were present, a deflecting magnetic field was used. It appears that the process of disintegration is not exactly the same for each individual nucleus. Either the mass of the aluminium nucleus is not constant or of that of the newly formed silicon nucleus, or both. Perhaps the energy change in the disintegration is not constant, and not all the nuclei may have identical masses. E. E. F. d'A.

3081. Disintegration with Loss of an α-Particle. D. Enskog. *Zeits. f. Physik*, 53. 9–10. *pp.* 639–645, 1929.

Continues the discussion of the assumption made in previous papers that α-radiation is governed by a quantum jump of the α-particle, which lowers its number of magnetons from 2 to 1. Calculations show that in the case of the high velocity α-rays, this quantum jump cannot take place without an addition of energy from outside, while with low-velocity rays energy is given out during the jump. The range of velocity calculated for rays of the first kind comes close to that observed in the case of the so-called penetrating α-rays. H. N. A.

3082. Irregularities of the Spread of α-Rays. P. Preisler. *Zeits. f. Physik*, 53. 11–12. *pp*. 857–886, 1929.

The variation of the spreading of α-rays from ThC′ in air, mica and bismuth was investigated by means of Geiger's counting apparatus. The widths of scattering found are actually greater than are calculated from existing theories, but it is pointed out that irregularities can be satisfactorily explained if it is assumed that for the retardation and scattering action not only the number and position of the electrons, but also their velocity in the atom should be taken into account. J. J. S.

3083. Distribution of Range of the α-Particles from Radium C′ and Thorium C′. N. Feather and R. R. Nimmo. *Cambridge Phil. Soc., Proc.* 25. *pp*. 198–204, *April*, 1929.

From expansion chamber measurements of the range of α-particles from thorium C′ and radium C′, statistical frequency curves were constructed showing the distribution of the range. The curve for thorium C′ is based on 2134 α-particle tracks, that for radium C′ on 729 tracks. Both curves depart from the normal Gaussian form and show an excess of low-range particles, although there is a marked difference in the proportion of short-range particles in the two cases. The possible causes of the deviations are discussed. Estimates are made of the linear straggling coefficients relative to the absorption of the two groups of particles in air, and the sources of error entering into this method of determining straggling coefficients are indicated. W. S. S.

3084. Ionisation Method for Investigation of Corpuscular Rays. Application to Detection of Atomic Disintegration. A. Wegerich. *Zeits. f. Physik*, 53. 11–12. *pp*. 729–746, 1929.

α-particles from Ra-emanation contained in an annular vessel bombard the material under examination, which is held above the emanation ring. The portion of the resulting radiations which is inclined at 130–150° to the direction of the primary α-rays passes downwards on to the ionisation chamber below the emanation ring. Arrangements are provided for screening any desired portion of the primary and secondary radiations. The inner walls of the ionisation chamber are coated with a magnesium mirror which is connected through a 3-valve amplifying circuit to telephones. The ionisation chamber is filled with neon-helium gas at 10 cm. Hg pressure, the rest of the apparatus being evacuated to 0·01 to 0·1 mm. Hg. Ionisation due to H-particles is recognised by the characteristic click in the telephones. The number of H-particles per millicurie of emanation per minute has been determined for carbon, aluminium, iron, copper and zinc. The disintegration of the first four of these elements, observed by Kirsch and Pettersson, is confirmed, and in addition zinc is found to be disintegrated. Contrary to Rutherford and Chadwick's findings, disintegration can be caused by α-particles of range below 3 cm. The minimum range of the H-particles given by R and C is not confirmed. Assuming a simple relation between the ranges of the primary α-particles and those of the resulting H-particles, the results, in terms of yield of H-particles per million α-particles, are in satisfactory agreement with those of other workers for aluminium, excluding H-particles of short range. The results for iron agree with those of Holoubek, but the deviation in the case of carbon is greater. A. J. M.

3085. Electrical Observation of Corpuscular Radiation. G. Ortner and G. Stetter. *Zeits. f. Physik,* 54. 7–8. *pp.* 449–476, 1929.

The various possibilities of observation of corpuscular rays are discussed. The employment for this purpose of reinforcement tubes, including electron tubes, was specially investigated. The intensification arrangements known in radio technics are not immediately available for the object in view, especially if the quantitative enumeration also of small mixtures of ions and their measurement are desired. An arrangement is described which affords what is required. The constituents of this are an entrance tube with high insulation and small lattice current, a not too high but accurate reinforcement and the string galvanometer. The arrangement serves the purpose of an electrometer for quick charges. A description of a research with α-rays from RaC is given. J. J. S.

3086. A Wilson Apparatus for Low Pressures. J. Petrová. *Zeits. f. Physik,* 55. 9–10. *pp.* 621–627, 1929.

A modified Wilson apparatus is described with which it is possible to obtain the paths of both α- and β-rays well exhibited down to pressures of 3 cm. Well-defined α-ray paths were seen with a pressure which was only about 0·5 cm. above the pressure of the saturated water vapour. The principle consists here also in the employment of the excess pressure in a space over against an evacuated space, but both these spaces are fully cut off from the mist chamber. J. J. S.

3087. Tracks of β-Rays. J. Petrová. *Zeits. f. Physik,* 55. 9–10. *pp.* 628–645, 1929.

By means of the apparatus described by the author [see preceding Abstract], the tracks of β-rays from radium D at various pressures were determined. A total number of 2070 paths were measured. For the two strongest secondary β-ray groups the mean and maximum track in air could be deduced. It also seems highly probable that the existence of one of the primary β-rays of the range belonging to RaD, of small extent of path, was detected. Several photographs of the observed tracks are given. J. J. S.

3088. New Kind of Fast β-Rays. D. Skobelzyn. *Zeits. f. Physik,* 54. 9–10. *pp.* 686–702, 1929.

In earlier work with a Wilson cloud apparatus and γ-rays, the author found the existence of quite characteristic long tracks of unknown origin [see Abstract 2563 (1927)]. They were undeviated by fields of 1500 gauss, and were not due to the presence of the γ-rays, nor were they α- or H-rays. They are here found to have an energy corresponding to 15,000 kV and an ionisation effect of 40 ion pairs per cm. path in normal air. They appear to be corpuscular rays of velocity comparable with that of light. The intensity distribution showed a marked falling off at large angles with vertical. They are attributes to a Compton effect of cosmic rays. J. E.

HEAT.

3089. Density of Molten Metals and Alloys. Expansion of Glass. Y. Matuyama. *Tohoku Univ., Sci. Reports*, 18. *pp.* 19–46, *May*, 1929. *In English. Report No.* 214 *from the Research Inst. for Iron, Steel and other Metals.*

The densities of the five molten metals Sn, Cd, Bi, Pb, Zn, and of seven of their binary and six of their ternary alloys, are determined by measuring the volume and mass of the molten metal in a glass or quartz apparatus of special shape. It consists of a cylinder A, 20 mm. in height and diameter, and a 3-mm. tube B rising from A and communicating, by a hole of 1 mm., with a lateral narrower tube C, which is bent down at right angles and ends in a 1-mm. hole. The whole apparatus fits into different compartments of an electric furnace, in which the metals (chemically pure, Kahlbaum or Merck) are fused. Tube C dips into mercury or into the fused metal which is drawn into A by evacuating B; the meniscus in B is observed. The expansion coefficient of the molten metal is almost independent of the temperature, but decreases slightly at high temperatures. The density of the melting metal is determined by extrapolation and confirmed by calculation. The atomic volume of an alloy is greater by 1 % maximum than the mean of the atomic volumes of its two or three constituents. The equation of van Laar and R. Lorenz for the relation between heat of mixture and volume change of binary alloys [see Abstract 1612 (1926)] is found to hold good. It was observed that soft glass (not further specified) could be used up to 540°, hard glass up to 710°; the expansion is first regular, but becomes greater above 490° and 630° respectively, and changes into a contraction at 545° and 765°. These figures, determined against a rod of fused silica, do not quite agree with those of H. Schönborn (*Keram. Rundsch.* 33. p. 18, 1925). H. B.

3090. Optical Measurement of High Temperature. G. Aeckerlein. *Zeits. f. techn. Physik*, 10. 4. *pp.* 129–136, 1929.

When the radiation coming from an oven is not completely "black," systematic differences are found between radiative and thermoelectric measurements of temperature. In the present method, the stream of radiation from a block of refractory material in the furnace is examined in directions making known angles with the surface. The experimental arrangements and the method of evaluating the results are fully described, and it is shown that a closer approximation to the equivalent "black-body" temperature may be obtained. A. A. D.

3091. Determination of Gas Temperatures by Measurement of Pressure Differences. H. Schmick. *Zeits. f. techn. Physik*, 10. 4. *pp.* 146–148, 1929.

A method for the determination of temperatures, dependent upon the fact that the pressure drop across an orifice through which a gas flows is, *ceteris paribus*, proportional to the temperature, is described, and illustrated by its use in determining the temperatures of a muffle furnace and of a Bunsen flame. J. S. G. T.

3092. Measurement of Temperature, Using a Light Filter. G. Naeser. *Zeits. f. techn. Physik*, 10. 5. *pp.* 160–163, 1929.

A long wedge, transmitting only two complementary wave-lengths, one in the red and one in the green, is interposed between the eye and the radiation from the furnace. The distance from the edge of the wedge to the point at which the transmitted light is white is found. This distance is a function of the temperature. A. A. D.

3093. Critical Temperature Measurements on Carbon Dioxide in Small Capillaries. H. T. Kennedy. *Am. Chem. Soc., J.* 51. *pp.* 1360–1366, *May,* 1929.

The critical temperature of carbon dioxide was measured in glass tubes varying in diameter from 0·004 mm. to 2·0 mm. It was found that the critical temperature was independent of the size of the tube, and 30·96° C. was taken as the most probable value. Great differences in the critical point were found for different methods of illumination, and depending upon whether a sharp meniscus or diffuse band were taken as a criterion. F. J. B.

3094. Cold Junction Correction of a Thermoelectric Couple. U. Retzow. *Zeits. f. techn. Physik,* 10. 5. *pp.* 164–167, 1929.

The corrections of the observed readings of a copper-constantan couple, necessitated by variations of the temperature of the cold junction from 0° C., are tabulated. The method of calculation is indicated. A. A. D.

3095. Improved Electrically-Heated Thermostat. P. van Campen. *Zeits. f. Elektrochem.* 35. *pp.* 265–266, *May,* 1929.

The present paper describes, with the aid of drawings, an electrical arrangement comprising a radio valve or triode adapted to regulate the action of an electrically-heated thermostat. J. K.

3096. Vacuum Bolometer as used in Measurements of Solar Radiation. N. Fairclough. *Phil. Mag.* 7. *pp.* 1067–1080, *June,* 1929. *Supplement.*

This paper records an attempt to find, for bolometer tapes of fixed length and width, the best thickness for use in measurements of solar radiation. The bolometer tapes form two arms of a Wheatstone bridge, the tape ends being at a constant temperature of 290° A., whilst the tapes are supposed to be heated to a central temperature of 350° A. by an electric current. One tape is exposed to solar radiation and the other shielded from it, a sensitive galvanometer giving a deflection which is made a measure of the sensitiveness of the bolometric apparatus for various thicknesses of tape. Nine different thicknesses were examined, from which it was concluded: (1) That the best tape to use is one whose thickness is between $11 \cdot 5 \times 10^{-5}$ cm. and $12 \cdot 5 \times 10^{-5}$ cm. (2) That where incident radiation raises the temperature at the middle of the exposed tape by 1° C. or less, then, for that particular tape, the deflection of the galvanometer is proportional to the intensity of the radiation. The best thickness as here determined is considerably smaller than that in use at the Smithsonian Observatory. H. H. Ho.

3097. Rectilinear Diameter of Ethylene. E. Mathias, C. A. Crommelin and H. G. Watts. *Ann. de Physique,* 11. *pp.* 343–353, *May,* 1929.

The observations have been made by methods in frequent use at Leyden. The equation to the diameter is $y = 0 \cdot 22179 - 0 \cdot 00061277$. Tables are given showing the values (calculated) of the latent heat of ethylene at different temperatures and the difference between the specific heats. A. A. D.

3098. Boiling Points of Hydrocarbons. B. Nekrassow. *Zeits. f. phys. Chem.* 141. *Abt. A.* 5–6. *pp.* 378–386, *May*, 1929.

On the basis of the empirical formula, $T_s = C \cdot \frac{M - \Sigma}{\sqrt{\Sigma}}$, where M is the molecular weight and Σ the sum of certain numerical equivalents, the boiling points of hydrocarbons of different types may be calculated to within about 5°, only the structural formulæ being considered. The methods employed open up the possibility of the numerical treatment of the influence of the structural elements of molecules on their boiling points. T. H. P.

3099. Coefficient of Cubical Expansion of Liquids and Critical Temperature. V. N. Thatte. *Phil. Mag.* 7. *pp.* 887–891, *May*, 1929.

A relation similar to that derived by Davies [see Abstract 1393 (1912)] from Mathias's law of rectilinear diameters and Guldberg's calculation of the ratio of densities of a liquid at 0° and at the critical temperature, is obtainable from the van der Waals equation of state. Representing the coefficient of cubical expansion by C, this relation has the form, $\frac{1}{C} = kT_c - 2T$, and this linear expression is found to agree closely with the experimental data for liquids; the value of k is taken as $2 \cdot 5$. This expression may be used to calculate the coefficient of expansion from the critical temperature, or *vice versa*, and holds also for liquefied gases. T. H. P.

3100. Measurement and Calculation of Magnitudes of Cooling. V. Conrad. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 183–189, 1929.

Simultaneous observations of air temperature, t, wind velocity, v (with an anemometer), and the cooling, measured with a Hill's katathermometer, were made for four months, at Salzburg, to obtain a comparison between the observed cooling (H) and the cooling (h) calculated from Hill's formula. The influence of temperature on cooling could be found directly only in calms, and to a first approximation the ratio H/h is little influenced by air temperature. The functional relation between H/h and v is given by $(H/h)\sqrt[6]{v} = 1 \cdot 01$. For very small velocities H/h is approximately 2, and it becomes nearly constant $(0 \cdot 9)$ for velocities greater than 1 m/s. With small corrections the formula can be used, for wind velocities exceeding 1 m/s., to calculate the cooling power in mg. cal./cm.^{2} sec. R. S. R.

3101. Exchange of Heat for Turbulent Motion with Liquids or Gases. S. Tarassenko. *Phys. Zeits.* 30. *pp.* 252–256, *May* 1, 1929.

The author has investigated the conditions for a plane surface, a tube and in a liquid. The theoretical formulæ obtained give good agreement with Nusselt's experimental results. A figure on logarithmic scale was set up to provide a comparison with the empirical formula of Nusselt obtained when investigating the heat exchange in a circular tube and Schiller's formula based on the law of Blasius. The author's curve approximates more to the former than the latter. Part of the difference is due to the use of shorter tubes by Nusselt, and the reasons for this are discussed. The practical truth of the author's formula has not yet been demonstrated. R. S. R.

3102. Semi-Empirical Vapour-Pressure Formula. V. Kirejew. *Zeits. f. Elektrochem.* 35. *pp.* 217–220, *May*, 1929.

The author had previously developed an empirical formula for the vapour pressure, $K = a(1{\cdot}10 - \tau)$, where the constant a is obtained at the boiling point τ_s, $a = K_s/1{\cdot}10 - \tau_s$. By combining this formula with the Clausius-Claperyon equation and with the Nernst equation a formula can be obtained which is applicable to different substances having normal vapour densities at high vapour pressures. F. J. B.

3103. Gaseous Effusion at High Temperatures. F. R. Bichowsky and C. W. Wilson. *Phys. Rev.* 33. *pp.* 851–859, *May*, 1929.

An apparatus has been constructed and described for investigating the effusion of gases through a small orifice, and the method has been applied to helium between the temperatures of 1000° and 2000° K., and at pressures from 0·2 to 0·8 mm. of mercury. The kinetic theory applying to the problem is discussed. It has been found that the effusion of the monatomic gas helium follows Knudsen's expression $N = PAN_L/(2\pi mkT)^{\frac{1}{2}}$. Keeping the rate of flow constant, *i.e.*, $N = N_0$, $P = P_0(T/T_0)^{\frac{1}{2}}$, if allowance is made for viscosity and slippage effects of the gas in the orifice chamber. It is suggested that the apparatus may be used to measure high temperatures as a gas thermometer. Experiments were carried out with hydrogen at temperatures from 1000° to 1900° K., but an interpretation of the results is not possible because of the presence of both molecular and atomic hydrogen in the orifice chamber at these temperatures. AUTHORS.

3104. Heat Equilibrium and Temperature. E. Wertheimer. *Zeits. f. Physik*, 55. 5. 5–6. *pp.* 395–408, 1929.

The paper supports a previous conclusion of the author [see Abstract 2124 (1925)] that the temperature of a gas cannot be defined kinetically but only electromagnetically. Two results are obtained, firstly that thermodynamical heat equilibrium between a mercury thermometer and the surrounding air only exists when the air is in radiation equilibrium with a black body, and secondly that the second law requires for the radiation equilibrium of a gas with a black body that the relation $ds = q/T = (dE + pdv)/T$ for a reversible process does not hold. The author's previous result may be stated thus—for a gas in a closed vessel with blackened walls the radiation from the walls at temperature T is $\psi = caT^4/4 = \frac{1}{4}c\int_0^\infty (8\pi v^3 h)/c^3 \,.\, dv/(e^{hv/kT} - 1) \ldots (1)$. The kinetic theory of gases requires for a gas in equilibrium in a closed vessel at temperature T, $L = 3RT/2M \ldots (2)$. The object of the present paper is to discuss these two general results and point out their real meaning and application. The case of the different temperatures given by a thermometer in air according to the covering of the bulb, and the shielding of the bulb from the sun's rays, is referred to, and the four states of equilibrium between thermometer and surroundings are as follows: (1) Conduction equilibrium and radiation equilibrium between thermometer and surroundings (thermodynamic heat equilibrium). (2) Stationary state of thermometer, neither conductivity nor radiation equilibrium. (3) Conduction equilibrium between thermometer and surrounding air in the absence of radiation equilibrium. (4) Radiation equilibrium between thermometer and surroundings when heat conduction is precluded. An investigation of these four cases allows a discussion of equations (1) and (2). This discussion takes up the rest of the paper, together with the application of the two laws of thermodynamics. Some conclusions are briefly as follows: (1) From equation (1) it follows that a true temperature can be ascribed only to a space and not to a substance or a quantity of energy. (2) It is most probable that the ordinary kinetic gas equation can be replaced by an electromagnetic one. T. B.

3105. Thermodynamics of Degenerate Gases. G. N. Lewis and J. E. Mayer. *Nat. Acad. Sci., Proc.* 15. *pp.* 208–218, *March*, 1929.

Considers further the fundamental relations between thermodynamics and statistics studied in previous papers [see Abstract 2243 (1929)]. Extends the work of Bose on photons and of Einstein on monatomic molecules to all types of molecules. Proves that Boltzmann's equation for distribution with respect to energy is invalid. E. E. F. d'A.

3106. Equation of van der Waals and Thermodynamics. J. E. Verschaffelt. *Comptes Rendus*, 188. *pp.* 1037–1039, *April* 15, 1929.

The paper forms a reply to V. Karpen [see Abstract 1932 (1929)]. The author draws a comparison with the variation of surface energy which only equals the work done by surface tension if the latter does not vary with temperature. He disagrees with Karpen's view that the work of molecular forces in vaporisation is proportional to the difference of density of the two phases as a necessary consequence of van der Waals' hypothesis, partially because it is assumed that A does not depend on temperature. The author corrects a mistaken view he indicated previously, that if $dS = dQ/T$ is a perfect differential for the homogeneous state, then the Maxwell-Clausius and Clapeyron relations can be verified. R. S. R.

3107. Cyclohexanol and the Third Law of Thermodynamics. K. K. Kelley. *Am. Chem. Soc., J.* 51. *pp.* 1400–1408, *May*, 1929.

When cyclohexanol is cooled slowly it undergoes a transformation at about 263·5° K. If cooled sufficiently rapidly, the high temperature form is supercooled and may be taken down to the temperature of liquid hydrogen. When heated, this supercooled high-temperature form exhibits regular specific heats up to about 135° K., where a very sharp rise occurs similar to that observed with glasses. This rise ends at 150° K., and at about 160° K. the supercooled form changes into the low-temperature form, this change taking place always at about the same temperature. Two measurements of the specific heat were made between 210° and 220° K. on the substance gradually changing into the low-temperature form. Above 230° K. the high temperature form is apparently highly stable and specific heat measurements were easily made up to the melting point. The heat of transition (at 263·5° K.) is 1960 cals. per mol. and the heat of fusion is found to be 406, which agrees moderately well with the value, 427, found by Cauquil by dissolving the crystalline and liquid forms at the same temperature (*Comptes Rendus*, 180. p. 1207, 1925). Calculation of the entropy shows that both crystalline forms have the same entropy at 0° K. The entropy and free energy of the liquid cyclohexanol at 298·1° K. are calculated. T. H. P.

3108. Thermodynamics of Mixtures. V. Fischer. *Zeits. f. Physik*, 54. 9–10. *pp.* 715–723, 1929.

A discussion is given of the conditions of equilibrium between a mixture of two ingredients and one of the two constituents which is in contact with the mixture through a semi-permeable partition. The partial pressure of a gas is calculated and the osmotic pressure of a dilute solution. Concentrations variously defined are discussed. A table is given comparing the values of the osmotic pressures of aqueous solutions of cane sugar calculated from the author's equations with those found experimentally by Morse, and between these the agreement is fairly good. J. J. S.

SOUND.

3109. Five-Stringed Cello. V. Karapetoff. *Frank. Inst., J.* 207. *pp.* 645–659, *May*, 1929.

Deals with mechanical and acoustical problems arising when a fifth string is added to the normal cello. After trial of various materials a hard-drawn brass wire of about 0·23 mm. diameter coated with gold about 0·015 mm. thick was used. Many difficulties were experienced, and on account of our imperfect knowledge of the acoustics of the cello much of the work was empirical. The gradual adjustment of the instrument to changed stress distribution caused uncertainty in otherwise quantitatively known modifications. Musical aspects of the problem are discussed in detail. See also the *Violinist*, Feb. and April, 1922.

W. H. Ge.

3110. Phenomena Due to Placing a Metallic Plate in a Beam of Ultra-Sonorous Waves. P. Biquard. *Comptes Rendus*, 188. *pp.* 1230–1232, *May* 6, 1929.

The ultra-sounds dealt with are produced by a vibrating plate of piezoelectric quartz, and the intensities are measured in water, using Langevin's method, by finding the radiation pressure on a flat box containing air. A plate of aluminium parallel to the wave-front is displaced in the direction of propagation, and the intensity of the ultra-sound beyond the plate shows maxima and minima. From these the wavelength in water can be obtained, and the velocity of the waves. Experiments with aluminium plates of different thicknesses show variations of the maxima with the thickness. Experiments were also made with the plate not parallel to the wave-front, and more complicated results were obtained.

H. N. A.

3111. Propagation of Sound in Gases. D. G. Bourgin. *Phil. Mag.* 7. *pp.* 821–841, *May*, 1929.

A mathematical attempt to link up explicitly the kinetics of sound with the internal constitution of the entities composing the gas. Abello's empirical conclusion was that the logarithm of the ratio of transmissions is a linear function of the concentrations. This can hardly be true in general, and even in the most favourable case we should expect ordinarily the ratio of two quadratics in the concentrations. Abello's relation holds in this extreme case only when the number of degrees of freedom of the component gases are the same. [See also Abstract 2157 (1928).]

E. E. F. d'A.

3112. Measurement of Sound Absorption Coefficients. P. E. Sabine. *Frank. Inst., J.* 207. *pp.* 341–368, *March*, 1929.

Using the equation $at_1 = (4V/v) \log_e (4E/avi)$, (where a = total absorbing power of the room; t_1 = time of reverberation; i = energy density at threshold of audibility; V = volume of room; v = velocity of sound; E = acoustic output in ergs per second of source of sound), experiments on the absorption power of various materials were carried out in a specially constructed room, with as source of sound a set of seventy-three open diapason organ pipes (pitch 64–4096 vib./sec.). The room was calibrated by the four-organ method. A loud speaker was found to be an unsatisfactory source of sound. It was shown that (*a*) decrease in humidity causes increase in absorption, especially with frequencies above 2000 vib./sec.; (*b*) absorption power (of hair-felt and an opening) does not increase strictly in proportion to area, but at a decreasing rate; it is also dependent on the shape of the opening, due apparently to diffraction effects; and (*c*) complex tones are absorbed more strongly than pure tones of the same pitch and intensity. Absorption coefficients thus depend on the exact conditions of measurement. A table of absorption coefficients for six different pitches is given for thirty-eight different materials; the most absorbent being (in approximately decreasing order) asbestos-akoustikos felt (3 in.–1·5 in. thick); acousti-celotex Type BB; and cotton fabric, 14 oz./sq. yd., draped to half area. C. A. S.

3113. Transmission of Sound through Partitions. Part II. Vibrating Partitions. A. H. Davis and T. S. Littler. *Phil. Mag.* 7. *pp.* 1050–1062, *June*, 1929. *Supplement.*

The paper is a continuation of previous work [see Abstract 1475 (1927)] on the measurement of the transmission of sound through partitions of various materials. In the method the test panel covers an aperture in a sound-proof wall between two rooms. A beam of sound is directed obliquely upon one side of the partition, and upon the other side measurements are made of the sound transmitted. Whilst the earlier work was concerned largely with panels of a felt-like nature, the present paper gives results for partitions—ranging from a sheet of paper to single- and double-board partitions and to a brick wall—which transmit sound to a greater or lesser extent by vibration. It is found that, in spite of partition vibration, the sound is transmitted as a beam, and measurements of transmission ratio are largely independent of the position in the transmitted beam at which measurements are taken. To reduce errors associated with single-point observations, a moving microphone was found to be advantageous. As an additional aid in avoiding difficulties due to interference systems in the test room, a trial was made of the use of a note of fluctuating frequency. The results of the measurements of sound transmission through panels of different types and weights are given, and selections are exhibited graphically. AUTHORS.

3114. Acoustics of Buildings. E. Scharstein and W. Schindelin. *Ann. d. Physik*, 2. 2. *pp.* 129–200, *June* 28, 1929.

These three papers deal with a study, by an oscillographic method, of the acoustic properties of auditoriums (*e.g.*, lecture theatres in the Technische Hochschule, München). The sources of sound employed were (*a*) impulsive in character or (*b*) continuous or musical sounds (a loud speaker, electrically operated, being used). The first paper, by Schindelin, deals mainly with a description of the method and apparatus: the loud speaker, microphone receiver, amplifier and oscillograph. The directional properties of the loud speaker and the receiver were determined experimentally. The papers are plentifully illustrated with instructive oscillograph records, showing the arrival of successive reflections from various parts of the auditorium. A. B. W.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

3115. Electromagnetic Equations. R. Lucas. *Comptes Rendus*, 188. *pp.* 1146–1148, *April* 29, 1929.

The electromagnetic equations of Lorentz lead to results in accord with experiment so long as stationary states are considered, difficulties being met with, however, as soon as accelerated motions are introduced. It is shown that for the case of charges in uniform motion the scalar and vector potentials ψ and A can be modified by the addition of a scalar ψ' and vector A′, which are such that the derived values of the magnetic and electric force remain unchanged. ψ' and A′ are shown to have the general form

$$\psi' = \Phi\left(t - \frac{xv_x + yv_y + zv_z}{c^2}\right)$$

$$A' = Kv\Phi\left(t - \frac{xv_x + yv_y + zv_z}{c^2}\right)$$

where Φ is an arbitrary function. The point of interest is that these correspond to a phase propagated with the velocity c^2/v (v is the velocity of the moving charge) in accordance with de Broglie's ideas. On this view the phase wave appears to possess both scalar and vector characteristics. W. S. S.

3116. Two-Dimensional Orbits in the Field of a Non-Neutral. M. A. Higab. *Phil. Mag.* 7. *pp.* 783–792, *May*, 1929.

The paper forms an extension of a discussion by D. Wrinch. [See Abstract 1680 (1922).] The general equations of motion of a charged particle in the field of an electric doublet are given and two types of motion are considered; (1) circular motion with constant distance of the electron from the centre of the doublet; and (2) general motion, where all the coordinates vary. For (2) there are two cases of periodic motion and four of non-periodic motion, the former being discussed in more detail.

R. S. R.

3117. Electrical Condition of Hot Surfaces during the Absorption of Gases. Part III. A Platinum Surface at Temperatures up to 850° C. G. I. Finch and J. C. Stimson. *Roy. Soc., Proc.* 124. *pp.* 356–365, *June* 4, 1929.

The following facts have been established: (i) The platinum sheet first becomes electrically charged at a temperature depending on previous treatment; (ii) oxidation, followed by reduction with hydrogen at 500° "normalises" the surface, which then exhibits a positive charge at room-temperature in contact with hydrogen or *in vacuo*; (iii) when heated to 660°, "normalisation" is again necessary; (iv) after "normalisation" at 850° the surface no longer gives a charge at room-temperature; (v) the charge on the "normalised" platinum sheet due to a gas is characteristic of the latter, dependent on temperature, and independent of gas pressure between 1 and 760 mm.; (vi) the charge due to the gases is rapidly removed by evacuation at 850°; (vii) the experimental results obtained with non-combining mixtures enable the gases examined to be placed in an order of their increasing activity in charging up the surface. These facts in conjunction with those of Part I [see Abstract 412 (1928)] and Part II [see Abstract 248 (1929)] indicate (i) that the " normalising " of a metal surface involves a rearrangement of the surface atoms by a process akin to sintering, and (ii) that platinum does not combine directly and form chemical compounds with any of the gases examined, some adsorbed gaseous molecules being condensed and forming an electrically neutral layer on the surface, and others held thereon by weak electrical attraction whereby one bond between the constituent atoms of each molecule is weakened. H. H. Ho.

3118. Temperature Coefficient of Piezoelectric Constant of Quartz. A. Andreeff, V. Fredericksz and I. Kazarnowsky. *Zeits. f. Physik*, 54. 7–8. *pp.* 477–483, 1929.

An experimental study of the effect of temperature (from 15° C. to 500° C.) upon the piezoelectric properties of quartz. An electric oscillation method was used and the quartz plate of the oscillator could be studied up to 575° C. The temperature effect is small. W. H. Ge.

3119. Motion of Ions in Constant Fields. L. Page. *Phys. Rev.* 33. *pp.* 553–558, *April*, 1929.

It is shown that the effect of a constant electrical or gravitational force F on ions passing through a constant magnetic field H is to cause the circular or helical ion paths to advance in a direction at right angles to both F and H with the constant velocity $u = c[F \times H]/eH^2$. Ion paths relative to a rotating earth are discussed on the assumption that the earth's field is purely magnetic relative to the inertial system of the centre of the earth. The essential features of the theory are shown to be unaltered if the constant mass of the classical theory is replaced by the variable mass of the relativity theory. [See next Abstract.] Author.

3120. Effect of the Earth's Magnetic and Electric Fields on Ion Paths in the Upper Atmosphere. L. Page. *Phys. Rev.* 33. *pp.* 823–831, *May*, 1929.

It is shown that the lines of force of the earth's magnetic field can be treated as if rotating with the earth in so far as the calculation of ion paths are concerned only if there exist positive charges over the poles accompanied by negative charges over the equator. The earth would have a total charge of − 72 coulombs although observers on the earth would be aware of no electric field. Assuming that the earth is an uncharged, conducting, uniformly magnetised sphere, rotating about its magnetic axis with angular velocity Ω, it is shown that ion paths progress to the west, the velocity of progression increasing with altitude so as to approach the limiting value $-\Omega \times r$ which measures the progression that would exist if the earth's field were solely magnetic relative to observers who do not partake of the rotation. The earth would have an apparent charge of + 72 coulombs although actually uncharged. It is shown that a uniformly distributed charge q on the earth merely changes the value of the limiting westward velocity found above, increasing the westward progression if q is positive, and decreasing it if q is negative. [See preceding Abstract.] Author.

3121. Testing the Atmosphere with the Help of Perturbations of the Electromagnetic Field at the Passage of the Twilight Band. J. Lugeon. *Comptes Rendus*, 188. *pp.* 1114–1116, *April* 22, 1929.

The author has found above Zurich, mainly during anticyclonic conditions, a cloud layer persisting possibly for several weeks with an associated temperature inversion but at a varying height. He considers this layer to be (1) the source of local atmospherics, very feeble, mainly nocturnal and disappearing under the photoelectric action of the sun, and (2) the seat of refraction or even total reflection of Hertzian waves. The height and thickness of this layer and other layers can be calculated from their effect on the electromagnetic field, since when rays pierce the layer a discontinuity in the record occurs. An analysis of the Zurich records shows that these effects indicate the height and temperature of the successive layers. Investigations of both the troposphere and stratosphere are thus possible, and facts regarding the Heaviside layer and Fabry's ozone layer are obtained. R. S. R.

3122. Variations in the Earth's Charge. R. Stoppel. *Gerland's Beitr. z. Geophys.* 21. 1. *pp.* 116–134, 1929.

Variations of the potential-gradient and conductivity of the air correspond with variations in the earth's local charge. Investigations into these charges made in Iceland, Hamburg and a rural district of the Mark Brandenburg give the same results. Extreme values are observed at midnight and noon. The electric charge is negative during the day, positive during the night. When the sky is overcast daily variations decrease and may disappear. Longer periods than daily can also be detected. Settled weather is indicated by the parallelism of electric and barometric curves, but divergence indicates the approach of unsettled weather conditions. W. A. R.

3123. Photographs of Lightning. B. Walter. *Phys. Zeits.* 30. *pp.* 261–267, *May* 1,1929.

The author discusses some of the photographs of lightning published in O. Prochnow's book *Erdball und Weltall* and criticises some of Prochnow's conclusions. The photograph taken by R. Süring in Potsdam is specially referred to. The author dissents from the view that the roughly parallel discharges shown in this photograph were simultaneous and considers that they rapidly followed each other. He explains the defective parallelism by variability of the wind, and a twisted portion in the picture of the discharge he concludes is due to whirling motion in the atmosphere. Some of the pictures in Prochnow's book described as globular lightning the author considers to be probably due to pictures of ordinary sources of light, such as street lamps, accidentally falling on the camera. Fine reproductions of Süring's photograph magnified three times, and a portion twelve times, are given in the paper. J. J. S.

3124. Study of Fulminating Matter: Its Explosion by Shock. E. Mathias. *Comptes Rendus,* 188. *pp.* 1208–1211, *May* 6, 1929.

Cites accounts which seem to show that "ball lightning" explodes when it impinges upon some solid. W. G. B.

DISCHARGE AND OSCILLATIONS.

3125. Temperature Oscillations of the Electrodes as Cause of the Hysteresis of Discharges. M. Wehrli and V. Hardung. *Helv. Phys. Acta,* 2. 2. *pp.* 115–135, 1929. *In German.*

Calculates the temperature of electrodes of different shapes, heat conductivity and heat capacity, considering the effect of a periodically variable energy stream impinging on them. Three laws are obtained connecting the temperature oscillations and the frequency of the energy stream. The amplitudes of the temperature oscillations increase with increasing frequency of impinging of the energy stream, finally becoming constant for the higher values of this frequency. There is a phase difference between the heat flowing in and the temperature oscillations, which increases with increasing frequency of heat absorption becoming, in the limit, $\pi/2$. An analogous phase difference occurs between the temperature and the energy flowing away along the electrode. This phase difference, in the limit, becomes $\pi/4$. The thermic relations developed form the foundation of the most frequently occurring types of hysteresis of discharges between electrodes with small separations, and from these relations a general method for the calculation of the dynamic characteristics is developed. Also, the relation between the impinging energy stream, the current and the electrode potential difference is extended to the theory of the non-stationary discharge from that for the stationary discharge. Two experimental methods are given for the obtaining of the relations for characteristic electrode surfaces between electrode temperature, current and voltage. Finally, it is shown that under certain conditions the Simon differential equation can be obtained, the constants of which are completely defined. R. C. F.

3126. Latent Carriers of Electricity in the Gaseous Discharge. S. A. Ratner. *Nat. Acad. Sci., Proc.* 15. *pp.* 318–323, *April* 15, 1929.

An ionisation chamber is placed in a large bell jar, in which discharges take place. The gas in the chamber communicates with the rest of the bell jar through a large number of slit-shaped channels, the opposite walls of which are oppositely charged, so that electrons and ions from the outer space will be attracted to the walls and will not enter the chamber. In spite of this large currents pass between electrodes in the interior chamber when discharge takes place outside. These appear to be due to metastable atoms which diffuse through the slits. It is assumed that mutual collision of two metastable atoms will produce a pair of ions, so that in this way ions will be produced inside the ionisation chamber. An estimate leads to the conclusion that the currents observed can be accounted for in this way. H. N. A.

3127. Mechanism of the Spark Discharge in Air at Atmospheric Pressure. L. B. Loeb. *Science,* 69. *pp.* 509–512, *May* 17, 1929.

The object of this paper is to give a modified form of the author's theory of the spark discharge which will account for the effects recently observed by Rogowski [see Abstract 2458 (1928)], Torok, Beams and the author [see Abstract 2169 (1928)]. It is shown that it is possible for potential gradients to exist between the electrodes of a spark gap far greater than the average potential gradient. Calculation of these potential gradients is extremely difficult, but rough computations indicate that they may be ten to twenty times the value of the average gradient. The theory satisfactorily accounts for the extremely short time-lag of the spark recently observed, which is of the order of 10^{-8} second. A. W.

3128. Electrodeless Ring Discharge Using Undamped Excitation. H. Steinhäusser. *Zeits. f. Physik,* 54. 11–12. *pp.* 788–797, 1929.

Measurements are described of the conductivity of the gas in discharge, transverse to the ring plane, and of the least current in the exciting coil necessary to start the discharge. The latter gives a relative measure of the striking voltage of the discharge. Undamped excitation was obtained by the use of large valves with an oscillatory circuit tuned to a frequency of $3 \cdot 75 . 10^6$ sec.$^{-1}$ ($\lambda = 80$ m.). The effect of change of gas pressure (up to about 10 mm. Hg) on conductivity and striking voltage was determined for the gases air, O_2, N_2, CO_2, H_2O, He, Ne and Ar. The general result was established that the pressures for minimum striking voltage and for maximum transverse conductivity respectively, coincide. For the rare gases the minimum striking potential was less than for the other gases and occurred at higher pressures. The curves for the rare gases showed also less pronounced maxima and minima. The effect of the free life period of the electrons in the discharge, leading to differences between experiments with damped and undamped excitation, is discussed. W. S. S.

3129. Electric Arc in Mixed Gases. F. H. Newman. *Phil. Mag.* 7. *pp.* 1085–1091, *June*, 1929. *Supplement.*

After a discussion of the work of various experimenters on the modification of spectra due to the presence of impurities experiments are described on the spectra obtained when an arc is maintained for a short time in helium and neon containing small quantities of impurities. The method of operating the arc was the same as in previous work [see Abstracts 485 and 569 (1929)]. Great difficulty was experienced in striking the arc in helium and neon atmospheres at all pressures from 10^{-3} to 1 mm. Even when the arc was started it could not be maintained, but with a small bead of borax fused on to the kathode this difficulty was eliminated. The characteristic radiations associated with helium and neon were absent, the core of the arc being brilliant white in colour with a surrounding column of yellow-coloured radiation which showed only the D lines. The Balmer lines were present together with the CN bands and many other lines which have not yet been completely classified. The helium and neon spectra could be detected when the dried gas was used, but even in this case the lines were faint compared with the other lines and bands. The faintness of helium and neon lines in this type of arc and the relative intensity of the CN bands, particularly those at $\lambda 3883$ and $\lambda 3590$, which are by far the most intense lines on the plates, are interesting, especially as the ordinary electric discharge through these gases gives the characteristic spectra associated with them. The results are discussed with reference to ionisation potentials. A. W.

3130. Numerical Value of Planck's Quantum of Action. F. Klingelfuss. *Zeits. f. Physik*, 54. 3–4. *pp.* 300–302, 1929.

From formulæ and constants previously obtained, the author develops a simple equation whereby the value of " h " can be estimated to a high degree of accuracy. The value obtained is $653 \cdot 8174 \times 10^{-29}$ erg sec., and the formula from which this is obtained gives " h " as directly proportional to the electrostatic unit of potential and the normal barometric pressure in mm. of mercury. It is inversely proportional to a constant which is obtained from the electrode function for spark potentials in air at atmospheric pressure. A value for the electronic charge in electrostatic units is also calculated and is found to be equal to $4 \cdot 774647 \times 10^{-10}$ e.s.u. [See Abstracts 1267, 1630 and 1631 (1929).] R. C. F.

3131. Space Charge Sheaths in Positive-Ray Analysis. R. W. Gurney and P. M. Morse. *Phys. Rev.* 33. *pp.* 789–799, *May*, 1929.

It is shown that in the usual ionising chambers used in the positive-ray analysis of secondary ion products a positive ion sheath is formed, which concentrates the field applied across the chamber into the portion of the chamber next to the slit, leaving the rest of the space field-free. A modification of the usual apparatus was used to check this fact. The sheath thickness varies with the voltage applied across the chamber, the electron current, and the pressure, and, inasmuch as some ions are formed best in a field-free space, and some best in a field, by varying any of the three variables we change the relative proportions of the various secondary and net primary ions reaching the analyser collector. Curves are given for the sheath thickness and for the various ionic currents through the slit for several conditions in the chamber, and these curves are checked with data given by several observers. This analysis shows the complexity of the phenomenon and indicates modifications in the experimental procedure which may help to clarify the interpretation of experimental results. E. E. F. d'A.

3132. Charge of Positive Ions from Measurement of Shot Effect. N. H. Williams and W. S. Huxford. *Phys. Rev.* 33. *pp.* 773–788, *May*, 1929.

Several new types of current fluctuations have been studied with special reference to the possible effects of both positive ions and electrons, and the influence of space charge. An emitter of positive potassium ions is described which has proved suitable for shot effect measurements. Results indicate that the discharge may be properly controlled and temperature limited currents obtained, giving a value for the K^+ ion equal in magnitude to the electron charge. Values resulting from an extensive series of electron charge determinations confirm the precision and expediency of several new methods which have been introduced into the experimental procedure. A detailed description is given of a simple and direct method of determining the shot circuit impedance. E. E. F. d'A.

3133. Photo Ionisation of Cæsium Vapour. F. L. Mohler, C. Boeckner. R. Stair and W. W. Coblentz. *Science*, 69. *p.* 479, *May* 3, 1929.

A repetition of previous measurements using a direct method. A mercury arc was used in conjunction with a number of filters, and it was found that the line 3130 had the greatest effect, longer waves having none. A value of $2 \cdot 3 \pm \cdot 2 \times 10^{-19}$ is found for the atomic absorption coefficient, compared to Little's value of $2 \cdot 2 \times 10^{-21}$. [See Abstract 1009 (1928).]

F. S.

3134. Ionisation of Hydrogen by its Own Radiations. J. Thomson. *Phil. Mag.* 7. *pp.* 970–980, *June*, 1929. *Supplement.*

An investigation was made to determine whether pure dry hydrogen gas is ionised by radiations emitted by a point discharge in the same gas. The results obtained appear to justify the assumptions previously made [see Abstract 1683 (1928)], showing that the presence of impurities in the gas or on the electrode surfaces is not a necessary condition for ionisation to occur. It is suggested that the ionisation takes place in two stages, the molecules absorbing two or more quanta of energy, either from the radiations or by collisions with other excited molecules. The results of this and preceding investigations are applied to the investigation by Chattock and Tyndall [see Abstract 967 (1910)] of the pressure of the electrical wind. It is shown that several peculiar phenomena encountered by these experimenters can be satisfactorily explained by consideration of the ionising radiations emitted by the gas in the immediate neighbourhood of metallic points charged to a high potential. A. W.

3135. Angular Scattering of Electrons in Helium, Neon, Hydrogen and Nitrogen. G. P. Harnwell. *Phys. Rev.* 33. *pp.* 559–571, *April*, 1929.

An attempt has been made to investigate in a qualitative way the angular distribution of electrons scattered by a gas. The gases which were used were helium, neon, hydrogen and nitrogen. The energy of the primary beam of electrons varied from 75 to 300 equivalent volts. It was found that those electrons which were scattered elastically were deflected in general through only a few degrees. In helium less than one-thousandth of the 200-volt electrons were scattered through 15°. Electrons which had sustained an exciting collision were scattered through slightly larger angles. Evidence of electrons which had suffered two inelastic collisions was obtained, these were distributed through still larger angles. A general tendency for slower electrons to be scattered through larger angles was observable. AUTHOR.

3136. Action of Metastable Atoms of Helium on a Metal Surface. M. L. E. Oliphant. *Roy. Soc., Proc.* 124. *pp.* 228–242, *May* 2, 1929.

The author describes a method for producing a beam of metastable atoms of helium by the impact of positive ions at glancing incidence on the walls of a gas-free platinum canal which serves to define the beam. These metastable atoms set free electrons from a metal surface with which they collide [see Abstract 711 (1929)], the maximum velocity of the electrons corresponding to the difference between the energy of the metastable state and the work function of the surface. A fraction of the metastable atoms can be reflected from a metal surface, the number so reflected varying with the gas condition of the surface. Experiments are described which prove directly the production of metastable atoms by glancing impact of positive ions on a metal surface. It is shown that some sputtering is produced by the impact of the fast moving neutral atoms, which possess a large fraction of the original energy of the positive ions from which they originated. The intensity of such disintegration is far less than that produced by positive ions, and suggests that the charge of the ion is a factor in the process. H. H. Ho.

3137. Rate of Formation of Negative Ions by Electron Attachment. A. M. Cravath. *Phys. Rev.* 33. *pp.* 605–613, *April*, 1929.

By a new method, the fraction h of the collisions between electrons and molecules which result in the attachment of the electron to form a negative ion has been measured in air and oxygen as a function of the average electron energy, the gas pressure and the moisture content. In oxygen h had a minimum at 0·9 volt average electron energy, and increased with either increase or decrease of the energy from this value. In air h increased as the average electron energy was reduced below 0·9 volt. The absolute value was about 0·4 of that predicted from the value in O_2, assuming simple additivity, but this difference is possibly within the limits of error. The variation with electron energy and the order of magnitude of h are in agreement with Bailey's results for air. On the other hand, a rapid increase in h with increase in pressure at constant electron energy was found at low energy, while Bailey's results, which seem more reliable, show no variation with pressure. In H_2O h is of the same order of magnitude as in O_2, but in mixtures of H_2O and O_2 h is much larger than in either alone, showing that here at least the attachment process is complex. Evidence of the detachment of electrons from negative ions in oxygen at very high fields was found. AUTHOR.

3138. Passage of Kathode Rays through Electric Fields formed by Grids. H. Bethe. *Zeits. f. Physik*, 54. 9–10. *pp.* 703–710, 1929.

A theory is developed relative to the research carried out by Hilsch and Pohl on the deviation of kathode rays by electric fields formed by grids with macroscopic grid constant. The theory explains why the deviated beam possesses nearly the same sharpness as the incident beam. As regards the magnitude of the deviation the theoretical values are only in partial agreement with the experimental results. In conclusion, an explanation is given why macroscopic grid deviation experiments such as those carried out by Hilsch and Pohl are not analogous to the refraction of de Broglie waves by crystal grids. [See also Abstract 932 (1929).] A. W.

3139. Experimental Test of the Maxwell Law of Velocity Distribution for Electrons from an Incandescent Kathode. A. Demski. *Phys. Zeits.* 30. *pp.* 291–314, *May* 15, 1929.

The calculation of the temperature of the incandescent kathode, on the assumption of a Maxwell velocity distribution, has in the past generally led to values considerably higher than those found by measuring the electrical resistance, though in some cases the values have been practically identical. The author has considered the matter theoretically, and with the help of experiments, and has cleared up the different sources of error. It was found that satisfactory measurements could only be made by completely eliminating the effect of the electric field produced by the kathode current on the electrons. This can be done by means of a suitable current breaker, which switches off the anode current during the time the heating current flows. A mechanical current breaker is described, which in some cases gave good results; but more constant agreement with theory was obtained with an alternating-current breaker. Difficulties were experienced with oxide and azide coated kathodes, owing to the difficulty of obtaining and maintaining a uniform and constant film. The final result of the investigation is that, under suitable conditions, agreement between the above-mentioned temperatures is obtained, which is in accordance with a Maxwell velocity distribution. H. N. A.

3140. Thermionic Emission through Double Layers. W. Georgeson. *Cambridge Phil. Soc.* 25. *pp.* 175–185, *April*, 1929.

General formulæ are obtained for the emission coefficients D(W) and graphs are drawn connecting the energies (W) of the electrons with D(W) for various thicknesses of layers, and for various values of the potential drops within them. It is shown that the emission coefficient does not vanish for $W = B$ as Nordheim states, but is of the order of $\frac{1}{2}$. [See Abstract 1959 (1929).] E. E. F. d'A.

3141. Electron Emission in Metals. L. Nordheim. *Phys. Zeits.* 30. *pp.* 177–196, *April* 1, 1929.

The modern theory of electrons in metals renders possible a pretty complete statement of all emission processes, including electric, thermal, and photo emission. More especially the characteristic form of the Fermi distribution, which supposes the presence of rapid electrons up to a limiting value, even at low temperatures, and a Maxwellian distribution of a much smaller number with considerably higher energy, must be taken as established beyond a doubt. [See Abstract 1277 (1929).] E. E. F. d'A.

3142. Electronic Refraction at Metallic Films. E. Rupp. *Ann. d. Physik*, 1. 6. *pp.* 773–800, *April* 6, 1929.

In the passage of slow electrons through metals, not only electrons in a continuous scattering cone, but also diffracted electrons, which are confined to selected angles, can be discovered [see Abstract 264 (1929)]. Photography allows of the fixation of the diffraction rings, but gives no indication of the velocity of the electrons or their number. To ascertain these the author uses an electric method, catching the electrons either on a ring or in a small movable Faraday cage. The position of the diffraction rings is given by the equation $\sin \phi/2 = 1/2\mu d \,.\, (159/V)$. The inner grating potential E_0 is found to be about 12 volt for silver and 17 volt for nickel. Diffracted electrons are defined as electrons undergoing no loss of velocity during deflection at a selective angle. All other electrons are scattered electrons. E. E. F. d'A.

3143. Maximum Velocity of Photoelectrons. H. Teichmann. *Ann. d. Physik*, 1. 8. *pp.* 1069–1095, *May* 7, 1929.

Describes a process of producing electrodes free of gas by the evaporation of metals in a high vacuum, and shows that in the region of the selective sensitiveness of potassium the maximum velocity of photoelectrons is according to Einstein's equation. E. E. F. d'A.

3144. Hydrogen Ions as the Cause of the Occurrence of Photoelectric Selectivity of Potassium. R. Fleischer. *Phys. Zeits.* 30. *pp.* 320–322, *May* 15, 1929.

Three methods of sensitising a potassium photoelectric cell in the presence of hydrogen are considered. It is shown that the vaporisation of the potassium plays an important part in the process. In the vapour state the potassium combines with hydrogen. Whether neutral hydrogen or the ion H^+ is the effective form cannot be decided. [See Abstracts 1298, 1654 (1929).] F. J. W.

3145. Outer Photoelectric Effect of Silver Halides and Silver Sulphide. F. Krüger and A. Ball. *Zeits. f. Physik*, 55. 1. *pp.* 28–43, 1929.

Measurements of the outer photoelectric effect of the silver halides and of silver sulphide have been obtained, for various wave-lengths, by means of an extremely sensitive electrometric method. Various amplifying methods were also tried in order to increase, if possible, the sensitivity of the measurements. The results show that the photoelectric effects for all the salts decrease rapidly with increasing wave-lengths, finally becoming asymptotic to the abscissæ. This asymptotic ending does not allow of a definite limit being given for the maximum wave-length at which the photoelectric effect occurs, but the following figures are given at which the effect was still to be observed by the authors' methods: 4070 Å. for silver iodide, 3320 Å. for silver bromide, and 3120 Å. for silver chloride. A comparison of these figures with those given by Kirillow [see Abstract 1519 (1929)] for the maximum wave-lengths of the inner photoelectric effects —4200 Å.–4320 Å. for silver iodide, 4300 Å. for silver bromide, and 3840 Å. for silver chloride—shows that the maximum inner photoelectric effect occurs at higher wave-lengths than those required for the outer photoelectric effect. This difference in limiting wave-lengths of the inner and outer photoelectric effects can only be explained by the fact that the electrons in passing from the crystal interiors to the outside space have to do work against a hindering surface layer, or against a voltage existing in this surface layer. A similar effect was observed in the case of silver sulphide, in which the maximum inner photoelectric effect is obtained with a wave-length of $1 \cdot 3\mu$ to $1 \cdot 4\mu$, whilst the outer photoelectric effect is only measurable up to 4070 Å. R. C. F.

3146. Photoelectric Effect of Aluminium and its Amalgam. A. Smits and H. Gerding. *Phys. Zeits.* 30. *pp.* 322–325, *May* 15, 1929.

The addition of small amounts of mercury to aluminium increases the photoelectric current four or five times. Further, the photoelectric threshold is altered. On the basis of the authors' theory of allotropy, it is suggested that this is due to a disturbance of the equilibrium which exists in aluminium between electrons, ions and atoms. F. J. W.

3147. Variation of the Photoelectric Effect with Temperature and Determination of the Long Wave-Length Limit for Tungsten. A. H. Warner. *Phys. Rev.* 33. *pp.* 815–818, *May*, 1929.

The photoelectric characteristics of a tungsten surface have been studied from room-temperature to 1140° K. It has been found necessary to use a tube of glass and quartz, and to seal it off the pumps after a thorough outgassing. The surface is rendered insensitive at room temperature by traces of gas, but regains its sensitivity between 800 and 900° K. The long wave-limit was found to be 2570 ± 50 Å, and was independent of temperature. AUTHOR.

3148. Effect of Ultra-Violet and X-Rays on the Steady Current Characteristics of Crystal Detectors. W. Jackson. *Phil. Mag.* 7. *pp.* 866–873, *May*, 1929.

Summarises the work on three theories of the crystal detector depending on (i) thermoelectric action at the light contact, (ii) electrolytic effects, and (iii) difference of electronic emissions from the two electrodes forming the contact. Experimental determinations have been made of the characteristic curves of the combinations, steel-carborundum and "Stutzberg," hertzite, galena and silicon crystals, before, during and after exposure to the rays. From the results it is not possible to decide as to the correct theory of crystal rectification. W. H. GE.

3149. Analysis of Triode Valve Rectification. S. E. A. Landale. *Cambridge Phil. Soc., Proc.* 25. *pp.* 355–367, *July*, 1929.

A quastic equation is developed to express the grid characteristic of a modern dull-emitter valve over a considerable range. From this the rectified currents and harmonics are calculated for applied wave-forms $E \sin pt$, $(A + B \sin nt) \sin pt$ and $(A + B \cos mt + C \cos nt) \sin pt$. It is shown that when an acoustically modulated radio-frequency voltage is applied to a cumulative grid rectifier an infinite number of harmonics is produced. G. E. B.

3150. Polarisation of Electron Waves. C. J. Davisson and L. H. Germer. *Phys. Rev.* 33. *pp.* 760–772, *May*, 1929. *Bell System Techn. J.* 8. *pp.* 466–481, *July*, 1929.

A homogeneous beam of electrons was reflected at 45° from the {111} face of a nickel crystal, and then from another connected with a Faraday collector. Only such electrons were accepted as had suffered no appreciable loss of kinetic energy. Selective reflection maxima were observed for bombarding potentials of 20, 55, 77, 103 and 120 volts. No variation of current was found with change in the planes of incidence of the two reflections, from which it is concluded that electron waves are not polarised by reflection. F. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

3151. Influence of Pressure on Conductivity of Metals at Low Temperatures. H. J. Seemann. *Phys. Zeits.* 30. *pp.* 256–258, *May* 1, 1929.

The pressure coefficient of the change of electric resistance of copper was measured at 0° C. and at $-195°$ C. in liquid nitrogen. The pressure coefficient $\gamma = \Delta w/w \, . \, p$, where Δw is the change of the resistance w under the pressure p. At 0° C. γ for Cu was found to be $-2 \cdot 14(\pm 0 \cdot 013) \times 10^{-6}$. This number was obtained from a large number of measurements at pressures between 50 and 150 kg/cm. The value differs by about 6 % from that obtained by Bridgman. The mean value of the observations at $-195°$ C. gave $\gamma = -5 \cdot 17 \times 10^{-6}$. Considering the measurements of K. Onnes and Beckman, it may be said that the pressure coefficient of the electric resistance of metals at low temperatures, in general, increases. J. J. S.

3152. Wave-Mechanics Calculations of the Variation of Electrical Resistance with Temperature. G. Borelius. *Zeits. f. Physik*, 54. 11–12. *pp.* 806–810, 1929.

It is pointed out that the results of calculations of formulæ for the change of resistance of pure metals with temperature, founded on the theory of de Broglie waves and brought forward by Houston, Frenkel and Mirolubow, and Bloch, do not agree with the experimental results. J. J. S.

3153. Temperature-Conductance Curves of Solid Salts. Part II. Halides of Potassium and Thallium. T. E. Phipps and E. G. Partridge. *Am. Chem. Soc., J.* 51. *pp.* 1331–1345, *May*, 1929.

Temperature-conductance curves for the solid halides of potassium and thallium were determined over wide temperature ranges. The materials were prepared from pure salts, and crystals were grown by the method of Tamman and Veszi, or pellets were prepared by compression of the fused salts. Two distinct slopes were observed for the potassium salts, as in the case of sodium [see Abstract 1103 (1926)], when the data were plotted to the axes log *k*, and 1/T. Thallium halides showed only one slope, except in the case of thallous iodide, which undergoes a change of crystal form. Change from uni-ionic to bi-ionic conduction seemed to characterise, and to be limited to, high-melting polar salts. Heats of liberation of the conducting ions in the various lattices were calculated from the corresponding slopes. F. J. B.

3154. E.M.F. of Thermal Agitation. E. K. Sandeman and L. H. Bedford. *Phil. Mag.* 7. *pp.* 774–782, *May*, 1929.

Refers to work by J. B. Johnson on the subject; confirmatory evidence has been obtained and a formula has been derived which will prove useful for calculating the magnitude of noise disturbance which occurs on the grid of the first stage of any amplifier, in R.M.S. microvolts. This formula contains a constant J, which depends directly on Boltzmann's constant *k*,

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and the value of *k* has been calculated from measurements made on various combinations of valves. The results agree with the accepted value of *k* satisfactorily. The effect of cooling grid leaks with liquid air was tried, and the resulting reduction in the observed microvolts recorded. The reduction ratio was in most cases less than the square root of the ratio between the absolute temperatures. A suggestion is made as to the reason for this. H. N. A.

3155. Properties of Dielectrics. Part I. Electric Moment and Molecular Structure. C. P. Smyth. *Frank. Inst., J.* 207. *pp.* 813–824, *June*, 1929.

This is the first part of a summary of the theoretical aspects of certain of the properties of dielectrics, and gives a short historical survey of researches on the relations between the electric moments, polarisations and molecular structures of substances, followed by a bibliography. The dielectric constant depends upon the number and the mobility of the electrons per cu. cm. of material, and, when the molecules contain electric doublets, to a much greater extent upon the size and arrangement of the doublets in the molecules, upon the freedom of the molecules to orient, and upon the number of molecules per cu. cm. J. J. S.

3156. Relation between the Electric Moment and the Potential Difference at an Interface. A. Frumkin and J. W. Williams. *Nat. Acad. Sci., Proc.* 15. *pp.* 400–405, *May*, 1929.

After a general discussion of the work of various experimenters the authors conclude that, while there is a striking similarity between the conclusions that can be drawn from electric moment data and those depending on interfacial potential difference data, any comparison between the two can only be qualitative. H. N. A.

3157. Electrostriction of Soluble Dipole Molecules. G. Jung. *Zeits. f. phys. Chem.* 3. *Abt. B.* 3. pp. 204–208, *May*, 1929.

A theoretical paper wherein it is shown that electrically neutral molecules having dipolar character give similar values to ions on electrostriction. J. K.

3158. Alteration of Dielectric Constant of a Very Rarefied Gas by Electrons. L. Bergmann and W. Düring. *Ann. d. Physik*, 1. 8. *pp.* 1041–1069, *May* 7, 1929.

In connection with the Heaviside layer the question of the alteration of the dielectric constant of the upper air by electrons becomes important. Experimental work by van der Pol, using the second method of Drude, on the alteration of the dielectric constant by ions, and the experiments of Gutton and Clément, are mentioned. Records experiments with electrons, using Drude's second method. A special tube is described, by means of which electrons from an incandescent kathode are sent through a grid to an anode passing between the plates of a small condenser which is placed between grid and anode. The alteration produced in the capacity of the condenser is measured by determining the alteration in the adjustment of a Lecker system of parallel wires sliding in tubes, which is required to restore resonance when the electrons are passed. The dielectric constant was diminished, and the diminution increased with increased density of the electrons. The values of the dielectric constant seemed to be in accordance with the theory. H. N. A.

3159. Dielectric Constant of Ionised Gases. H. Gutton. *Comptes Rendus*, 188. *pp*. 1235–1237, *May* 6, 1929.

Continuing the experiments on ionised gases in high-frequency fields [see Abstracts 1635, 1636 (1929)], it is now shown how the dielectric constant of the ionised gas can be determined as a function of the number of ions per c.c. The dielectric constant is determined experimentally by introducing the gas tube into a condenser forming part of a Lecher wire system, and finding the resonance length of the wires under different conditions. By combining the results obtained with the formula relating conductivity and resonance wave-length ($\lambda^2 i^{0\cdot75} =$ constant), it is found that K_ω (dielectric constant) $= 1 + \frac{0\cdot278 \,.\, 10^{10}N}{35\cdot5 \,.\, 10^{10}N^{0.75} - \omega^2}$, where N is the number of ions/c.c. For the wave-length $\lambda = 2\cdot487$ metres, resonance occurs for an ionisation of $N = 1\cdot9 \,.\, 10^8$ electrons per c.c. W. S. S.

3160. Dielectric Constants of Metallic Vapours. F. Krüger and F. Maske. *Phys. Zeits.* 30. *pp*. 314–320, *May* 15, 1929.

Dielectric constants were measured by oscillating valves employing the "heterodyne beat" method as described by F. Maske [see Abstract 2825 (1929)]. Values were obtained for the vapours of mercury, sodium and rubidium at various temperatures and pressures. It is shown that Maxwell's relation $\epsilon = n^2$ is not valid. It is impossible to extrapolate to the liquid and solid states by means of the Clausius-Mosotti law. G. E. B.

3161. Anomalous After-Effect with Quartz. H. Saegusa and S. Shimizu. *Nature*, 123. *pp*. 713–714, *May* 11, 1929.

A note reporting on anomalous after-effect on the apparent resistivity of a quartz plate cut perpendicular to its optical axis. The effect is believed to be due to some property of the atomic lattice of quartz. W. H. GE.

3162. Dielectric Constants of Imperfect Insulators. R. T. Lattey and O. Gatty. *Phil. Mag.* 7. *pp*. 985–1004, *June*, 1929. *Supplement.*

In determining the capacity of a condenser at high frequencies the inductance of its leads should be considered and corrections made for the effects of leakage. The corrections which should be applied to the observed values are: (1) the capacity of the leads; (2) the inductance of the leads; (3) the conductance of the dielectric or leakage; (4) the earth capacity, or the capacity of the condenser relative to its surroundings; (5) correction for the resistance of the leads. Rarely, if ever, have investigators corrected for all these sources of error. In their measurements the authors adopted a method of tuning for maximum difference of potential which is described. In finding the relation between capacity observed and dielectric constant a variable condenser of large capacity was used to determine the dielectric constants of a few good insulators, and then small condensers were calibrated by the use of these fluids. The liquids used were carbon tetrachloride, chloroform and a mixture of these. The small condensers were then tested with air, the above liquids, methyl alcohol, nitrobenzene and water in them. The dielectric constants of these liquids and benzene were measured at various temperatures, and the results compared with those obtained by other observers are given in tables, with references at the end to eighty-two papers giving earlier measurements of dielectric constants.

J. J. S.

3163. Logarithmic Deflection Indicator. M. B. Manifold and A. S. Radford. *Journ. Sci. Instruments*, 6. *pp.* 145–151, *May*, 1929.

For many purposes it is useful to plot the logarithm of an observed electrical quantity against some other variable. This is done usually by observing the linear deflection, tabulating the logarithms of the readings and then plotting from these results. It is a great convenience if the indicating instrument can be made to perform this conversion—this is specially necessary when photographic records are being taken. In the final form of design used here a vibration galvanometer is fed by a constant frequency current from a steady oscillator, through a special transformer, the state of saturation of the core of which is controlled by the current to be measured flowing in a third winding. The instrument works over a current range of 100 to 1, and a frequency range of 50 to 10,000 cycles.

A. A. D.

ALTERNATING CURRENTS AND MAGNETISM.

3164. Crystal Structure and Ferromagnetism. W. Schmidt. *Phys. Zeits.* 30. *pp.* 259–261, *May* 1, 1929.

Reference is made to a paper by v. Auwers [see Abstract 1425 (1929)] in which is discussed the change of atomic distance with temperature for the α and γ forms of iron. The author gives an equation which correlates the temperatures of the above and other changes which take place in iron, *viz.*, $\mathrm{T} = n\mathrm{T}_s/m$, where T is the temperature of the change, n is a whole number from 1 to 14, m is 14, and T_s is the melting point. The changes in iron are tabulated so far as they are known, and the application of the equation to other metals is discussed.

G. E. A.

3165. Magnetic Transformation Points. E. Lehrer. *Zeits. f. techn. Physik*, 10. 5. *pp.* 177–185, 1929.

In the usual methods of ascertaining the magnetic transformation points of small samples of ferromagnetic substances, difficulties arise from the want of complete saturation by the relatively weak coils employed. This tells against accuracy in the results. The author describes an apparatus in which the saturation is complete, based upon Curie's method (*Journ. de Phys.* (3) 4. (1895), 197, 263), and applicable to microanalysis.

A. D.

3166 Magnetic Properties of Ferric Oxide and certain Ferrites above their Curie Points. (Miss) A. Serres. *Comptes Rendus*, 188. *pp.* 1239–1241, *May* 6, 1929.

Above 700° C. iron-oxide has a paramagnetic susceptibility independent of the temperature. The value is such that it may be regarded as due to γ-iron, which may thus be supposed to be the same in combination as in the free state. In the case of four ferrites (for instance, $\mathrm{Fe_2O_3 \cdot MgO}$) the temperature-susceptibility relation suggests the superposition of a constant paramagnetism (due to the iron-oxide) on a variable paramagnetism.

A. A. D.

3167. Ferromagnetic and Paramagnetic Curie Points. R. Forrer. *Comptes Rendus*, 188. *pp.* 1242–1244, *May* 6, 1929.

The Curie point of a ferromagnetic found from the usual thermomagnetic observations differs from the same point obtained from extrapolation of Weiss's paramagnetic law. In nickel this difference is about 16° C. Observations on nickel suggest that the region up to the lower point is characterised by the existence of spontaneous orientation. In the intervening region there is still some effect due to hysteresis, and above the upper point the substance is truly paramagnetic. A. A. D.

3168. Magnetic Losses of Iron in H.F. A.C. Fields. J. R. Martin. *Phys. Rev.* 33. *pp.* 621–624, *April,* 1929.

A number of investigators have studied the power loss due to eddy currents and hysteresis in iron when placed in h.f. a.c. fields, but the results obtained are in wide disagreement. Using a new method, the author has investigated the variation of this loss with the frequency for several areas of cross-section. The total loss is considered as that due to an equivalent resistance, and by measuring the values of this resistance at resonance the loss may be determined from the I^2R relation. With magnetising currents of 3, 4 and 5 ampere-turns per cm., the measurements are made on short iron cylinders of various areas of cross-section at frequencies ranging from 520 to 968 kilocycles. The loss is found to increase with frequency in the small samples and to decrease with frequency in the larger. At any particular frequency the loss per unit volume is less the greater the area. This is due to the magnetic shielding effects of eddy currents in the large samples and the disagreement between previous investigations may thus be explained. AUTHOR.

3169. Magnetic Declination and Horizontal Intensity in Austria. F. Hopfner. *Gerlands Beitr. z. Geophys.* 21. 4. *pp.* 373–386, 1929.

In 1920 observations were made in the neighbourhood of Wiener-Neustädt with an Eötvös balance. Simultaneously, at the same points, the declination and the horizontal intensity were measured. The present paper contains the magnetic observations. A. A. D.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3170. Synopsis of the Radiological Work of the Strangeways Research Laboratory, Cambridge. S. E. Cox and E. G. Spear. *Brit. J. Radiology* 2. *pp.* 222–227, *May,* 1929.

3171. Bioelectric Currents Amplified. E. Benedetti. *Accad. Lincei, Atti,* 8. *pp.* 696–700, *Dec.* 16, 1928.

The author previously described apparatus for amplifying bioelectric currents up to five-valve power and acoustically transforming or recording these on a drum [see Abstract 1995 (1928)]. Now he describes an eight-valve arrangement for photographic recording. Investigations are given as to the changes in the curves under the action of various drugs. A. D.

3172. Relative Efficiency of Pads Moistened with Saline Solution and Lead Plates as Electrodes with Diathermy Current. G. Simon. *Brit. J. of Radiology,* 2. *pp.* 242–248, *May,* 1929.

On a living subject the maximum temperature recorded by an alcohol thermometer on the skin is slightly greater with lead sheets as electrodes than when pads soaked in 16 % saline were used. The maximum temperature obtained just beneath the skin was also greater with lead electrodes than with saline-soaked pads. The difference, however, is only 0·7° C. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3173. Adsorption of Hydrogen on the Surface of an Electrodeless Discharge Tube. M. C. Johnson. *Roy. Soc., Proc.* 123. *pp.* 603–613, *April* 6, 1929.

The progressive decrease (called "fatigue") in the rate at which hydrogen disappears under the action of a discharge was examined by means of the ring discharge [see Abstract 2165 (1928)] induced from outside a glass bulb. The bulbs used (two of soda glass, about 150 cc.) were baked out at 300° and experiments conducted at 20°. Pressures were measured by specially designed micromanometer (fully described) able to measure pressures of 10^{-4} mm. Saturation was reached in about 4′ at a residual pressure of 0·05 mm. (but on repetition after rebaking at successively higher pressures—0·063 and 0·07 mm.). As all possibility of H_3 is excluded and H_2 is not adsorbed the hydrogen is adsorbed as H_1. The mean distance between atomic centres is shown to be $1\cdot3$–$1\cdot8 \times 10^{-8}$, as compared with $1\cdot06 \times 10^{-8}$ (Bohr's normal orbit), and $1\cdot9 \times 10^{-8}$ if assumed attached to the glass atom by atom. Thus the ratio of actual to maximum close packing is 0·36–0·66, and the layer is never of more than monoatomic thickness. Heat of adsorption is $1\cdot06$–$1\cdot115 \times 10^4$ cal./gm. mol.

C. A. S.

3174. Adsorption Process. W. Kälberer and C. Schuster. *Zeits. f. phys. Chem.* 141. *Abt. A.* 4. *pp.* 276–296, *May,* 1929.

The size and properties of the surface of silicic acid gels are measured by the isotherms and the heat of adsorption of different gases such as carbon dioxide, nitrogen and ethylene. The relationship between the degree of adsorption and the heat of adsorption has also been investigated as well as the dependence of the adsorption on the previous handling of the gels. The dependence of the heat of adsorption of carbon dioxide on the temperature was deduced from the isotherms and also experimentally determined. [See Abstract 1347 (1929).]

J. K.

3175. Cataphoretic Measurements and Theory of Critical Potential. H. R. Kruyt and D. R. Briggs. *K. Akad. Amsterdam, Proc.* 32. 4. *pp.* 384–391, 1929.

Experiments with various sols show, in every case, that univalent kations which are highly adsorbed and cause flocculation at low concentrations reduce the cataphoretic migration velocity uniformly to approximately the same value, at the concentration of total precipitation, as that characteristic of the multivalent ions at their corresponding concentrations. Various anomalies are shown by the curves connecting cataphoretic velocity with salt concentration. Thus, barium chloride always gives a curve in which the cataphoretic velocity is reduced very quickly to a value very near to that shown at the concentration of complete precipitation, after which the curve is nearly flat for more than half its length on the axis of concentration; further, the flocculation value appears to decrease with time. Aluminium chloride gives unexpected results with gold sol, probably owing to the presence of a small proportion of alkali in the sol and the consequent removal of the aluminium ion by precipitation as hydroxide. Taken as a whole, the results show with certainty that when flocculation can be brought about in low concentrations of electrolytes, the migration velocity is always reduced to the same value when precipitation occurs. [See Powis, Abstract 848 (1916).] T. H. P.

3176. Critical Solution-Temperature Phenomena in the Ternary System Phenol, Thymol-Water. Kathleen W. Wilcox and C. R. Bailey. *J. Phys. Chem.* 33. *pp.* 705–708, *May*, 1929.

Thymol and water become more soluble in one another as the temperature rises, but there is no critical solution temperature to correspond with that of phenol and water which one of the authors has already placed at 65·3° C. and 36·5° phenol. A diagram has now been constructed to show the critical solution temperatures of ternary mixtures at 15°, 65°, 120°, 200°, and 250° C. At 15° C. a small proportion of thymol increases the solubility of phenol in water, which increases quickly to a maximum; but larger quantities of thymol then reduce the solubility of phenol in the mixture, which falls to a minimum and then increases until the phenol and the aqueous thymol became completely miscible. Above the critical solution temperature of phenol and water only the minimum is observed, but it is noteworthy that whereas at intermediate temperatures the miscibility of thymol and water is increased throughout by the addition of phenol, there is at 200° C. and 250° C. the addition of phenol first decreases and then increases the mutual solubility of thymol and water. T. M. L.

3177. Producing Thin Films of Organic Compounds on Mercury Surfaces. R. L. Keenan. *Kolloid Zeits.* 47. *pp.* 289–294, *April*, 1929.

Organic films are better floated on mercury than on water, which reacts with the compounds. The author lets one drop of the solution of cellulose acetate, etc., fall upon the mercury in a trough; the contour of the film is not regular but jagged. Unless the mercury had been purified by electrolysis for three days and repeated distillations, the liquid would not spread; a thin film of the compound, to be removed for fresh experiments, then kept the surface clean for weeks. The thickness of the film is estimated from planimeter measurements of the area and from the weight of the drop. The thickness increases with increasing complexity of the atomic groups, from 1·5 Å. for caoutchouc (dissolved in petroleum ether, elastic film) to 2·5 and 5 Å. for cellulose solutions (acetates and nitrate, dissolved in acetone or chloroform) and to 7 Å. for gelatin. The films seem to consist of chains or groups of molecules lying flat on the surface, perhaps in network structure, but not standing on the surface as the fatty acids do on water. H. B.

3178. Coagulation of Colloidal Ferric Oxide. C. H. Sorum. *Am. Chem. Soc., J.* 51. *pp.* 1154–1162, *April*, 1929.

A conductance-diffusion method for studying the coagulation of colloidal ferric oxide by electrolytes is described, and data are presented to show the application of the method. AUTHOR.

3179. Lake Formation and Dyeing of Cotton. E. Baur and H. Schnyder. *Zeits. f. Elektrochem.* 35. *pp.* 254–263, *May*, 1929.

Historical and theoretical data are given on the question of whether there exists a chemical combination between fibre and dye. The present authors have obtained distribution curves for immunised, mercerised and ordinary cotton. Various acid and basic dyestuffs have been used in this connection and it is deduced that a chemical combination takes place. J. K.

3180. Meaning of Absorption of Ions by Colloidal Particles on Coagulation by Electrolytes. H. Freundlich, K. Joachimsohn and G. Ettisch. *Zeits. f. phys. Chem.* 141. *Abt. A.* 4. *pp.* 249–269. *May,* 1929.

The present investigators have found that the quantity of kation absorbed by the negative sols such as arsenic sulphide and gold are not equivalent as it has been frequently assumed according to the theory of electrolyte coagulation of hydrophobic sols. The experimental work of Schulze, Linden, Picton and Hardy and Powis is referred to. The colloidal adsorption values for different electrolytes are quantatively determined at the flocculation point of arsenic sulphide and gold sols. The amount of hydrogen ions removed is also measured, the values approaching those of other kations, such a result confirming the work of Rabinowitsch [see Abstract 2872 (1928)]. Exception is taken to the general application of the theory of Freundlich. J. K.

3181. Thixotropy of Dispersions of Low Concentration (Bentonite). E. A. Hauser. *Kolloid Zeits.* 48. *pp.* 57–62, *May,* 1929.

Referring to Freundlich [see Abstract 1695 (1929)] the author finds that bentonites (clay) in natural dispersions of about 10 % show thixotropy. The property vanishes on dialysis, but reappears on addition of electrolyte (KCl). When too much KCl is added, however, the Brownian movements stop (first the translation, then the rotation), and flocculation takes place; the observations are made with a slit ultra-microscope of Leitz and bentonite of high dilution (concentration 0·26 %). The cessation of the mobility is ascribed to progressive hydration of the particles. The thixotropic phenomena depend upon the dimensions of the apparatus used, and results are only comparable for the same dimensions. H. B.

3182. Synæresis. S. Liepatoff and A. Kuhn. *Kolloid Zeits.* 48 *pp.* 62–63, *May,* 1929.

Controversy with Kuhn [see Abstract 1696 (1929)] who had misunderstood certain statements by the author. The author's curve of liquid separation and jelly concentration, showing a maximum at mean concentration as resulting from the tendency of hydration of geranin and the dehydrating influence of the salt, was kinetic and not intended to mark an equilibrium condition for all concentrations. Several misprints in his translated paper are pointed out (seconds instead of hours, etc.). In his reply **A. Kuhn** states that he was aware of the kinetic character of the curve, which would yet lead to his conclusions. H. B.

3183. Influence of Electrolytes on the Viscosity of Colloids. N. R. Dhar and S. Ghosh. *Kolloid. Zeits.* 48. *pp.* 43–49, *May,* 1929.

This paper extends previous work [see Abstract 2624 (1927)] and records viscosity measurements for more than 30 sols, whereby it is found that the viscosities after addition of electrolytes are smaller than those of the pure sols. The data of other authors is quoted in support of the present results. The viscosity rises with the degree of purity, and it is found that with increasing purity the hydroxide sols of chromium and zirconium become viscous. The viscosity of a pure zirconium hydroxide sol falls by about one-half on the addition of a 1 % zirconium oxychloride solution. The purer the sol, the smaller its stability towards electrolytes. Previous assumptions are confirmed, *viz.*, that the viscosity is smaller, the higher the charge, and that under the same conditions the uncharged substance is more highly hydratised than the charged sol. The sol of silicic acid behaves like other colloids in the presence of small amounts of electrolyte. By addition of larger amounts of electrolyte the sol is not coagulated, but the hydratation decreases in consequence of water expulsion from the particle surfaces, and the viscosity becomes smaller. Evidence is put forward against the untenability of the view that the stability of a sol (lyophile or lyophobe) is connected with the degree of hydratation. H. H. Ho.

3184. Colloidal Chemistry in the Tanning Industry. G. Sándor, *Kolloid. Zeits.* 48. *pp.* 96–103. *May,* 1929.

The present paper summarises progress during the past five years of colloidal chemistry in the tanning industry under the headings: Chemistry of the Proteins; Glutin; Preparation of the Hides; Action of Neutral Salts; Vegetable Tanning Extracts and Tannage; Theory of Vegetable Tannage; Chrome Tanning; Theory of Chrome Tanning; Other Mineral Tanning Processes; and finally Fatting and Dressing. The paper contains seventy-five references to various publications under the above subjects and constitutes a most valuable bibliography. H. H. Ho.

3185. Influence of Elements on the Allotropic Transformations of Iron. A. Heinzel. *Zeits. f. techn. Physik,* 10. 4. *pp.* 136–137, 1929.

Discusses the relation between the influence of certain elements and their place in the Periodic System. A. A. D.

3186. Systems Iron-Beryllium and Iron-Boron. F. Wever. *Zeits. f. techn. Physik,* 10. 4. *pp.* 137–138, 1929.

The diagrams of the two systems are given. The crystal structure of the compound $(Fe_2B)_x$ is discussed. A. A. D.

3187. Distribution of Austenite in Specimens of Quenched Carbon Steels. K. Honda and A. Ôsawa. *Tohoku Univ., Sci. Reports,* 18. *pp.* 47–58, *May,* 1929. *In English. Report No.* 215 *from the Research Inst. for Iron, Steel and other Metals.*

By means of X-ray analysis it is confirmed that in quenched specimens the amount of retained austenite is greater in the outer layer than in the inner. For the same steel, this difference increases as the quenching temperature is raised, and for the same quenching temperature it increases with the carbon content. AUTHORS.

3188. Theory of the Dissolution of Metals and Alloys. M. Centnerszwer. *Zeits. f. phys. Chem.* 141. *Abt. A.* 4. *pp.* 297–320, *May,* 1929.

General review of the conclusions drawn from recent researches in the Riga Laboratory [see Abstract 1422 (1928)] and elsewhere. The dissolution of metals in acids is most easily controlled by measuring the volume of hydrogen evolved, and that method is used when other means, titration, etc., are not needed. In the simplest case of the alkali and alkaline earth metals, whose potentials are more negative than $-1\cdot55$ volt, the total reaction depends merely upon the rate of diffusion of the solvent to the surface of the metal; but rate of solution of the surface and that of the core have always to be distinguished. Passivity is ascribed to a diminution in the rate of formation of ions, supertension to a diminution in the rate of discharge of the ions. The induction period of self-activation of a pure metal ends when the supertension has fallen to its minimum, after the inactive film has been dissolved. In alloys the induction periods are very long; it is not so far explained why metals of lower supertension than zinc yet retard the dissolution of zinc by their presence. When metals are catalytically deposited during the solution, the end of the induction period will occur when the deposit forms a continuous kathode. All the phenomena can be regarded as dependent upon the rates of chemical reactions and diffusion and upon local electric currents. H. B.

3189. Decomposition of Nitrous Oxide in the Silent Electric Discharge. Part IV. Influence of Addition of Foreign Gases. S. S. Joshi. *Faraday Soc., Trans.* 25. *pp.* 137–143, *April*, 1929.

The gases added are such as are considered neutral towards nitrous oxide, at least in the thermal sense. Compared with nitrogen it is shown that an admixture of oxygen has a marked effect in increasing the ratio of nitrogen to oxygen in the final mixture. The two equations, namely: $4N_2O = 3N_2 + N_2O_4$ and $N_2O_4 = N_2 + 2O_2$, proposed formerly to represent the mechanics of the decomposition, are now considered with reference to $2N_2O = 2N_2 + O_2$. [See Abstract 2321 (1929).]

J. K.

3190. Action of Hydrogen Chloride on Alcohol. S. Kilpi. *Zeits. f. phys. Chem.* 141. *Abt. A.* 5–6. *pp.* 424–450, *May*, 1929.

This paper considers more particularly the effect of electrolytes upon velocity of reaction. The equilibrium coefficients of the previously developed velocity equations for the action of hydrogen chloride upon alcohol have been determined in mixtures containing 25 and 50 mol. % ethyl alcohol at temperatures of 96·5° and 110° C., and also in the presence of sodium and potassium chlorides. The value of the equilibrium coefficients C_2/C_1 increases with electrolyte concentration (0·05 to 0·8 N.), but more slowly the greater the concentration. Since C_2 appears to be independent of the electrolyte concentration, the velocity coefficient C_1, for the reaction between hydrogen chloride and alcohol, decreases with concentration. At the concentrations investigated, no difference was noted with respect to the effects of hydrochloric acid, sodium chloride, and potassium chloride. An attempt is made to explain the dependence of velocity reaction upon electrolyte concentration by means of the theories of Brönsted and of Debye and Hückel. It appears that the velocity of the reaction between hydrogen chloride and alcohol changes with the electrolyte concentration proportionally to the product of the electrometrically measured hydrogen and chlorine ionic activities. H. H. Ho.

3191. Photochemical Temperature Coefficients. W. D. Bancroft and R. P. Allen. *Nat. Acad. Sci., Proc.* 15. *pp.* 445–448, May, 1929.

The conception of chemical depolarisers introduced by Grotthus over a century ago may be applied also to thermal depolarisation. A simple high-temperature ozoniser has been devised, capable of being heated either electrically or in a gas-fired combustion furnace to any desired temperature. This consists of two concentric porcelain tubes sufficiently long to extend well out of the heating zone, so that the cool ends of the outer tube traversed by the gases or vapours may be suitably closed. To excite the tube use was made of a Tesla, high-frequency, oscillatory discharge with an estimated voltage of 250,000. This device is employed to study the decomposition of acetaldehyde, which decomposes thermally at about 400° C. into methane and carbon monoxide. Under the influence of the oscillatory discharge, simultaneous occurrence of the two reactions, $CH_3.CHO$

$\rightarrow CH_4 + CO$ and $2CH_3 . CHO \rightarrow C_2H_6 + 2CO + H_2$ is observed. Measurements of the gas evolution at temperatures ranging from 80° to 340° C. show that, in agreement with the view of Grotthus, the temperature coefficient increases rapidly with the rise of temperature. Theoretically the curve obtained by plotting photochemical reaction velocity against temperature seems to consist of three parts: a rapidly ascending part at low temperatures, a nearly horizontal part over a considerable range, and a rapidly ascending part as the region of thermal instability is approached.

The behaviour of hydrogen-chlorine mixtures at $-12°$ C. appears to have a bearing on the Einstein law of quantum equivalence in photochemistry. If Amato's statement that these mixtures are not photosensitive at $-12°$ C. (*Gazz. Chim. Ital.* 14. p. 57, 1885) is correct, the apparent quantum yield drops from about 1,000,000 molecules at ordinary temperatures to zero at $-12°$ C. T. H. P.

3192. Regularities in the Ionic Radii of the Elements. V. M. Goldschmidt. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 451–452, *May,* 1929.

In reply to Berkenheim [see Abstract 2629 (1929)] the author points out that both his own determinations and Pauling's calculations were based on too uncertain data to justify any conclusions as to the greater reliability of the one or the other results. H. B.

3193. Spectroscopic Estimation of Unstable Intermediate Products in Activated Gases. Z. Bay and W. Steiner. *Zeits. f. phys. Chem.* 3. *Abt. B.* 2. *pp.* 149–161, *May,* 1929.

Spectroscopic study of the absorption bands would be more instructive if the bands were not mostly in the far ultra-violet. In order to shift them into the visible spectrum an emission spectrum is produced in the already activated gas; but further effects of the direct discharge should be prevented by making the reaction tube electrodeless [see Abstract 3024 (1928)] or by providing it with external electrodes. The authors use a discharge tube I, 2·5 cm. wide, 3 m. long, with Al electrodes and connect it with a reaction tube of the same width, 4 m. long, fitted with external tin foil electrodes or surrounded by a coil, which may be the coil of the transformer in which high-frequency undamped oscillations are induced by a valve. The activated gas is pumped from the discharge tube into the reaction tube. Another discharge tube II used opens out into a bulb of 17 cm. diameter, which is fitted with external tinfoil electrodes; this arrangement proved convenient for the study of momentary changes in a gas at rest. In molecular hydrogen, previously studied by the authors [see Abstract 572 (1929)] and by Hiedemann [see Abstract 2167 (1928)], both the Balmer series (atomic spectrum) and the many lines (molecular spectrum) are seen in case I, and the gradual fading of the H-atom intensity at a definite spot can be watched in case II. Nitrogen shows the arc spectrum of N^+ in the negative glow of the activated gas and further, in the same glow, the red and violet arc lines of N, so far not observed outside the discharge tube. The study of the glow in activated oxygen was much disturbed by the presence of impurities. H. B.

3194. Bond Cleavage on Catalytic Hydrogenation in Presence of Nickel. Function of the Catalyst in Heterogeneous Catalysis. A. A. Balandin. *Zeits. f. phys. Chem.* 3. *Abt. B.* 3. *pp.* 167–194, *May,* 1929.

From numerous experimental data an empirical rule is deduced whereby predictions can be made as to the sequence in which the bonds in an organic molecule will be broken down on hydrogenation with a nickel catalyst. If the numbers 1, 2, 3 and 4 are applied to the elements Cl (or Br), O, N and C, respectively, then on catalytic hydrogenation the comparative stability of the bond between any pair of these atoms is indicated by the product π of the numbers ascribed to the elements. Thus for the bond N, O, π is 6, while for C, N, π has the value 12, and in the catalytic hydrogenation of nitromethane with a nickel catalyst methylamine and water are produced at 170° C., while methane and ammonia are obtained by treatment at 300° C. The rule applies whatever the number of bonds between the atoms. The sequence of bond cleavages is dependent on the catalyst. The bonds most readily broken on hydrogenation are not necessarily those which are least stable in the free molecule: special stability relations prevail on the surface of the catalyst, and the ease with which a group of atoms is detached from the molecule is proportional to the affinity of the group for the catalyst. A thermodynamic basis for the empirical rule is deduced from energy considerations, which are also applied to other reactions occurring in the presence of nickel, *e.g.*, dehydrogenation of hydrocarbons, amines and alcohols, hydrogenation of double bonds, dehydration of alcohols and several condensation reactions.

A. J. M.

3195. Theory of Cracking Petroleum. H. A. Wilson. *Roy. Soc., Proc.* 124. *pp.* 16–45, *May* 2, 1929.

The composition of a hypothetical oil may be represented by the formula CHx when it consists of a mixture of a number of hydrocarbons, x representing the number of hydrogen atoms per carbon atom in the oil. Under certain conditions of temperature and pressure a state of dynamical equilibrium will be set up between the constituents, the molar amounts of the members of each homologous series forming a geometrical progression, with a ratio of between successive terms which depends on the temperature and pressure. Using the results obtained in previous papers, the author applies his theory to the calculation of the percentage amount of gasoline and of gas obtained at temperatures ranging from 750° F. to 1400° F., at pressures ranging from 7·5 atmospheres to 60 atmospheres and for oils with $x = 2{\cdot}25,\ 2{\cdot}20,\ 2{\cdot}15$ and $2{\cdot}10$, on the assumption that no coke is formed in the apparatus. When coke is formed it is easy to allow for this. These theoretical results are compared with those obtained in practice, both for liquid phase cracking and vapour phase cracking; and practical rules are deduced governing the rate of cracking and the volume of the reaction chamber.

H. N. A.

3196. Rôle of Electricity Carriers in the Explosion of Combustible Gases Mixed with Air. F. Haber. *Preuss. Akad. Wiss. Berlin, Ber.* 11. *pp.* 162–170, 1929.

The work of Malinowski (*J. Chim. Phys.* 21. pp. 469–478, 1924) on ionisation in the wave of propagation of explosions is discussed. In the experiments now described, use is made of a wedge-shaped electrical condenser, through the continuous field of which are passed explosive mixtures of gases and vapours with air. Under these conditions the explosive flame is influenced only if the burning gaseous mixture is a good conductor. The results obtained with various mixtures indicate that the process of combustion and, in particular, the velocity of propagation of the ignition are determined, not by electrical particles, but by uncharged radicles. This corresponds with the standpoint of Bonhœffer and Haber [see Abstract 1186 (1929)] and is explained by the fact that the uncharged radicles are produced with considerably less expenditure of energy than the charged ones. Only with the radicles C . C and possibly CH, which possess exceptionally low excitation potentials, does the ionisation potential appear low enough to permit appreciable splitting into ions and electrons in the air flames. Hence, in the latter, which exhibit a well developed Swan spectrum, a slight influence of a superposed voltage on the velocity of propagation of ignition is observed. The essential source of the ionisation is the chemical energy of the elementary combustion processes. T. H. P.

3197. Velocity of Reaction, Concentration and Activity. A. Skrabal. *Zeits. f. phys. Chem.* 3. *Abt. B.* 4–5. *pp.* 247–270, *May*, 1929.

The formula, developed by J. N. Broensted, connecting the velocity of reaction as directly proportional to the activity of the reacting substances, and inversely proportional to the activity coefficients of the unstable critical complexes, was developed in a new way. The formation of intermediate products and their subsequent decomposition to form the final substance, and the velocities of these stages were discussed, and developed mathematically. F. J. B.

3198. Gas-Metal Electrodes. S. J. French and L. Kahlenberg. *Am. Electrochem. Soc., Trans.* 54. *pp.* 163–190; *Disc.*, 190–199, 1928.

The behaviour of gas-metal electrodes in KCl was studied. The method used was a development of methods previously employed by the authors [see Abstract 362 (1929)]. The potentials measured were found to be related to the absorbing power of the metal for the gas. Oxygen tended to make the metal potentials less basic, while nitrogen and hydrogen have the opposite effect. Elements having amphoteric properties, variable valencies, and known to function as catalysts, show greater changes with hydrogen and nitrogen than do the more simple and pronouncedly metallic elements. Coating the electrodes and stirring the electrolyte prevented the condensation of the gas film on the surface of the electrode, and did not allow the correct potentials to be measured. F. J. B.

3199. Use of Metals for Indicator Electrodes. J. O. Closs and L. Kahlenberg. *Am. Electrochem. Soc., Trans.* 54. *pp.* 369–392; *Disc.*, 392–396, 1928.

The use of various metals for electrodes in the potentiometric titration of acids and alkalies was investigated. The effects of the various factors on the potentials were studied. The observations were made upon electrodes made of tungsten, molybdenum, arsenic, antimony, bismuth, aluminium and tin, and these electrodes showed great differences of potential in $0 \cdot 1N$ acids and $0 \cdot 1N$ NaOH. It was shown that these metals can be used as electrodes for the titration of acids and bases by the potentiometric method, and gave satisfactory end points. Results of a few titrations with electrodes of thallium, platinised platinum and zinc were included and the theory of the process was discussed. F. J. B.

3200. Calcium Amalgam Electrodes in Dilute Aqueous Solutions. R. J. Fosbinder. *Am. Chem. Soc., J.* 51. *pp.* 1345–1356, *May*, 1929.

A method of determining the activity coefficients of calcium ions was developed. Calcium amalgam was prepared from calcium and mercury, and its potential in aqueous solutions of calcium salts was measured by means of a dropping electrode. The results for the activity coefficients of calcium chloride were determined over a range of concentrations from 0·01 to 3·3 molal. The values up to a concentration of 1·0 molal agreed with those obtained by Lucasse. Values of the activity coefficients of calcium ions in aqueous solutions for five calcium salts were determined from 0·01 to 0·001 molal. It was not possible to apply the method to the determination of calcium ion activities of physiological solutions. Protein lowered the potential of the electrode. F. J. B.

3201. Potential of Inert Electrodes in Solutions of Sulphurous Acid and its Behaviour as an Oxidising and Reducing Agent. A. A. Noyes and H. H. Steinour. *Am. Chem. Soc., J.* 51. *pp.* 1409–1428, *May*, 1929.

The potentials of the sulphite half of various cells of the type $Pt \mid H_2SO_3 + HA(c_1) \mid HA(c_2) \mid H_2 + Pt$, where c_1, c_2 are such that the hydrogen ion concentration of both solutions are equal, have been determined. All possible reactions have been discussed and the free energies and potentials at 25° calculated. A fairly constant figure of $-0\cdot37 - 0\cdot03 \log (H^+)^{\frac{1}{3}}$ is obtained provided the cell has stood quiet for many hours. This result is independent of the concentration of sulphurous acid, or of the presence of sulphuric, dithionic or hydrochloric acids, but is consistent with the hypothesis that sulphurous acid is reduced to hyposulphurous acid ($H_2S_2O_4$), equal quantities being formed and decomposed in the steady state. At 25° sulphur cannot be the effective reduction product, but may be so at 50°. At 25° a solution of sulphurous acid (SO_2 1 atmo. and H^+ concentration 1 molal) may oxidise any oxidation-reduction combination with reduction potential less negative than $-0\cdot37v$, may reduce one more negative than $-0\cdot14v$, and may oxidise or reduce one with potential between $-0\cdot37$ and $-0\cdot14$, which occurs depending on the relative rates of the two reactions, though apparently oxidation is the more rapid. Increase in hydrogen ion concentration shifts the limits of both actions towards increasing negative potential. C. A. S.

3202. Influence of the Solvent on the Electromotive Force of Silver Haloid Cells. Part I. Mixtures of Water and Ethyl Alcohol. A. S. Afanasiew. *Zeits. f. Elektrochem.* 35. *pp.* 220–222, *May*, 1929.

The combination $Ag \mid AgCl \, . \, KCl \mid KBr \, . \, AgBr \mid Ag$ was prepared with water solutions and with three mixtures of water and ethyl alcohol. The electromotive force of the combination was measured, and compared with the calculated value obtained from the formula used by Brodsky for a similar combination of mercury and mercury salts. A very good agreement was obtained between the observed and calculated values. F. J. B.

3203. Thermodynamic Study on Lead Monoxide. F. Ishikawa and E. Shibata. *Tohoku Univ., Sci. Reports*, 18. *pp.* 109–119, *May*, 1929. *In English.*

Measurements on the e.m.f. of a number of cells consisting of $Pb \text{ amalgam} \mid PbO \; NaOH \mid H$ were carried out. The e.m.f. was determined at different temperatures, and by combining the results with existing data several thermodynamic quantities relating to lead monoxide were calculated. The entropy of PbO at 25° C. = 18·89 entropy units, and the dissociation pressure of PbO at 25° C. was found to be $1\cdot52 \times 10^{-66}$ atmosphere. F. J. B.

3204. Electrolytic Potentials of Certain Metals. L. Bouchet. *Comptes Rendus*, 188. *pp*. 1237–1239, *May* 6, 1929.

The electrolytic potentials were derived from measurements of the e.m.f. in cells of the types:

$$E' = \mathrm{Hg} \mid \mathrm{Hg_2Cl_2},\ \mathrm{KCl} + \mathrm{KCl} \mid \mathrm{SO_4X} + \mathrm{SO_4X} \mid \mathrm{X}$$
$$E = \mathrm{H} \mid \mathrm{HCl} + \mathrm{HCl} \mid \mathrm{SO_4X} + \mathrm{SO_4X} \mid \mathrm{X}$$

where X represents the metal under investigation. The results are summarised in the following table:—

Metal.	Electrolytic Potential.	
	Calomel Electrode = 0.	Hydrogen Electrode = 0 (730 mm. Pressure).
Mg	− 1·766	− 1·485
Zn	− 1·052	− 0·771
H	− 0·281	—
Cu	+ 0·041	+ 0·324
Ag	+ 0·502	+ 0·788

A computed correction for the liquid/liquid potential jumps was allowed.

W. S. S.

3205. Some Exceptions to Volta's Law. O. Scarpa. *Elettrotecnica*, 16. *pp*. 366–367, *May* 25, 1929.

The combination copper-mercury-zinc-copper shows a slight e.m.f. in spite of all precautions to keep the temperature constant. The e.m.f. falls off gradually, and is accompanied by an alteration in the state of the immersed electrodes. A combination in which cadmium is substituted for zinc behaves similarly.

E. E. F. d'A.

3206. Capacity in the Aluminium Cell. E. M. Dunham. *Phys. Rev.* 33. *pp*. 819–822, *May*, 1929.

A new means of measuring the capacity of aluminium anode films is described in which the solid film capacity is measured without disconnection of the direct current used for film formation. The usual method of measurement has necessitated this disconnection and thus introduced an error in results due to the rapid recovery of the cell within the disconnection period. Results are obtained which verify the conclusions of A. L. Fitch [see Abstract 347 (1917)] and W. E. Meserve [see Abstract 3226 (1927)]. It is found that the capacity of the solid film of oxide is inversely proportional to the quantity of electricity passed through the cell, and that the resistance of the anode film in solid form is directly proportional to the quantity of electricity passed. If the film is composed of Al_2O_3 its resistivity and dielectric constant are about $1{\cdot}5 \times 10^{10}$ ohm. cm. and $7{\cdot}7\mu f$/cm. respectively. These values, because of the assumptions made in their calculation, are probably correct only in order of magnitude.

AUTHOR.

3207. Potential Difference of Dilute Solutions. M. Planck. *Preuss. Akad. Wiss. Berlin, Ber.* 1–2. *pp*. 9–11, 1929.

The fundamental difference between the two formulæ advanced respectively by Henderson and the author for giving the magnitudes of the p.d. between two infinitely dilute solutions has been already indicated [see Abstract 1773 (1928)]. The following experiment is now suggested as a means of judging between these two formulæ. If, from any two solutions 1 and 2, a third, 3, is prepared by mixing, the p.d. E = 1|2|3|1 should be zero according to Henderson, and, in general, different from zero according to the author. Investigations on these lines are now in progress, and if, as Büchi's results would indicate [see Abstract 224 (1925)], they confirm Henderson's formula, it would appear that when two solutions are allowed to mix, even if the utmost precautions are taken, convection plays a far more important part than the true diffusion occurring when the liquids are at rest. T. H. P.

3208. Potentiometric Study of the Reactions between Ferrocyanide and Ceric Ions. N. H. Furman and O. M. Evans. *Am. Chem. Soc., J.* 51. *pp.* 1128–1133, *April*, 1929.

One of the advantages of solutions of ceric sulphate containing sulphuric acid, not mentioned by other workers in this field, is that ceric salts [see Abstract 2865 (1928)] are almost unique among stable oxidising agents in having a kation as primary active constituent, instead of the anions of permanganates, chlorates, etc. The reaction

$$Ce^{++++} + Fe(CN)_6^{----} \rightleftharpoons Ce^{+++} + Fe(CN)_6^{---}$$

proceeds quantitatively from left to right in acid solution, and from right to left in alkaline solution (30 % potassium carbonate). The potentiometric titration of ferrocyanide with ceric sulphate is accurate through a wide range of conditions. The presence of a small quantity of ferric iron in the ceric solution causes a greenish coloration (of ferric ferrocyanide) which disappears sharply at the end point of the oxidation of the ferrocyanide, and this visual end point is practically identical with the potentiometric end point. The reverse titration of ceric sulphate with ferrocyanide is only accurate when the bulk of the ferrocyanide is added very rapidly. H. B.

3209. Electrolytic Solution Forces and the Electrolytic Ionic State. Part VI. K. Fredenhagen. *Zeits. f. phys. Chem.* 141. *Abt. A.* 3. *pp.* 195–216, *April*, 1929.

Continuing previous work [Abstract 2034 (1929)] the deviations from the dilution law are discussed from the standpoint of the inter-ionic forces and of the solution forces. Certain objections were raised against the fundamental theory of inter-ionic forces that the solution ions were solvated gasions, and that the reciprocal action between the solvent and dissolved substance was independent of the concentration. By means of calculations, based upon assumptions better supported by data and used by the author in his theory of solution forces, the same results on the deviation from the dilution law were obtained. The bearing of the condition of the solution ions on the absorption spectra was outlined. F. J. B.

3210. Activity Coefficients of Ions in Very Dilute Methyl Alcohol Solutions. J. W. Williams. *Am. Chem. Soc., J.* 51. *pp.* 1112–1119, *April*, 1929.

The activity coefficients of a number of salts in dilute methyl alcohol solutions were determined. The effect of solvent salts of two-valency types on the solubility of highly insoluble saturating salts, also of two-valency types, was used as a measure of the activity coefficients. The results showed that if the solutions were made sufficiently dilute the Debye-Hückel theory is obeyed in methyl alcohol solutions for saturating salts of the simpler valency types. The importance of the study of inter-ionic attraction theory in media whose dielectric constants lie between that of water and methyl alcohol was stressed. F. J. B.

3211. Osmotic and Activity Coefficients. R. C. Cantelo. *J. Phys. Chem.* 33. *pp*, 627–632, *April*, 1929.

Mathematical. In their theory of strong electrolytes Debye and Hückel deduced formulæ for the potential energy of the ions in the solution and for the electric free energy of the solution, the latter formula involving the ionic diameter. The theory has been tested by various investigators with respect to the expressions for the osmotic coefficient and the activity coefficient derived from it. The author gives a simple alternative derivation of these equations. H. B.

3212. Number of Water and Alcohol Molecules Taken up by the Silver Ion. G. C. Schmidt and M. Keller. *Zeits. f. phys. Chem.* 141. *Abt. A.* 5–6. *pp.* 331–342, *May*, 1929.

The smallest e.m.f. is capable of sending a current through silver-nitrate solutions, which must, therefore, contain some ions free from combined molecules. The change produced in the transference numbers when the combined molecules are replaced by ammonia or pyridine shows that, on the average, one silver ion exists in solution in conjunction with two molecules of water or methyl alcohol; the aqueous solution contains also the ion $Ag(H_2O)$. Measurements of the freezing point depression and electrical conductivity indicate that addition of ammonia or pyridine to the solutions results in the formation of the complex ions $Ag(NH_3)_2$ or $Ag(C_5H_5N)_2$, which are more stable in alcohol than in water, and apparently are not associated with molecules of the solvent. T. H. P.

3213. Budde Effect in Bromine and Chlorine. G. B. Kistiakowsky. *Am. Chem. Soc., J.* 51. *pp.* 1395–1399, *May*, 1929.

The Budde effect in bromine is left entirely unchanged by drying or moistening or carefully purifying the halogen, so that Lewis and Rideal's statement that proportionality exists between the concentration of the water vapour and the magnitude of the Budde effect must be incorrect [see Abstract 215 (1928)]. Similar results are obtained with chlorine. It is pointed out that dry mixtures of hydrogen and chlorine cannot be prepared in Pyrex-glass apparatus, since this glass is reduced at its softening point by hydrogen with formation of water. T. H. P.

3214. Internal Pressure of Strong Electrolytes. H. M. Evjen and F. Zwicky. *Phys. Rev.* 33. *pp.* 860–868, *May*, 1929.

It is shown that the difference in thermal properties of dilute solutions against those of the pure solvent is due to the superposition of two effects: (1) A physical effect of the ion on the solvent, which is manifested as an internal pressure varying from point to point in the solution. This pressure distribution is calculated for aqueous solutions of monovalent salts by an approximation theory in which the effect of the so-called ion atmosphere is estimated by means of the Debye-Hückel potential. In this, as in ensuing calculations, the thermal properties of the solvent are assumed to be known. The effect of this internal pressure on the thermal coefficient of expansion and on the compressibility of dilute binary solutions is calculated, and the results are found to be in satisfactory agreement with experimental values. (2) Definite evidence is obtained that the second effect determining the thermal properties of solutions is due to a chemical action of the ion on the solvent. This effect increases linearly with the molal concentration. As a result of the present paper and previous work, to which reference is given, we can say that the caloric as well as the thermal behaviour of dilute solutions is duly accounted for. AUTHORS.

3215. Electrolytic Formation of Sodium Arsenate. O. Essin. *Zeits. f. Elektrochem.* 35. *pp.* 234–240, *May*, 1929.

Reference is made to the work of Lloyd and Kennedy, and experimental data are given on the exact analytical determination of As^{iii} and As^{v}. On electrolysing a solution containing 80·5 gm. of As_2O_3 and 100·6 gm. of NaOH per litre without a diaphragm, using iron electrodes and a current density of 0·03 A/cm.^{2}, a large kathodic reduction of the electrolytes to metallic arsenic takes place. On electrolysis of the same solution with a diaphragm, there is formed at the anode a hard crust, which is permanent if the As_2O_3 concentration at the commencement is diminished. J. K.

3216. Theory of Deposition of Chromium from Aqueous Chromic Acid Solutions. E. Müller and J. Stscherbakow. *Zeits. f. Elektrochem.* 35. *pp.* 222–234, *May*, 1929.

In spite of its strong oxidising action, pure chromic acid is not electrolytically reducible in aqueous solution, but it becomes so on addition of SO_4'' – ions. By tracing kathodic current-voltage curves and determining the interruption potentials, results are obtained which confirm the theory previously advanced, namely, that the kathode becomes coated with an invisible, non-conducting, fine-grained layer, which prevents the reduction of the chromic acid. This layer becomes charged in presence of SO_4'', but this occurs only after a certain kathode potential has been attained. It is hence concluded that charging by the SO_4'' ions necessitates the electrostatic attraction of these ions by the layer mentioned. The difference in behaviour between platinum and chromium kathodes is interpreted in the sense of the theory in question, and a preliminary hypothesis is advanced to explain the varying behaviour of platinised platinum and carbon kathodes. [See also Abstract 2045 (1929).] T. H. P.

3217. Electrolytic Reduction of Benzoic Acid. F. Somló. *Zeits. f. Elektrochem.* 35. *pp.* 264–265, *May*, 1929.

The author criticises the interpretation of the experimental results obtained by Bauer and Müller and laws that the product obtained by them, having a boiling point of 187° to 192° C., is not a single substance as assumed by them, but is a mixture probably of ethyl benzoate, benzyl alcohol, hydro-benzoin and other derivates having a similar boiling point. J. K.